BECHTEL JACOBS
Bechtel Jacobs Company LLC

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Job No. 23900
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October 15, 2003

Mr. William E. Murphie, Manager
Portsmouth/Paducah Project Office
U.S. Department of Energy
1017 Majestic Place, Suite 200
Lexington, KY 40513

Dear Mr. Murphie:

**DE-AC05-03OR22980: Final Report – *Beryllium Sampling Project at the Paducah Gaseous Diffusion Plant* (BJC/PAD-581)**

A sampling project was designed and executed to measure beryllium in selected U.S. Department of Energy (DOE)-owned facilities at the Paducah Gaseous Diffusion Plant. Sampling was conducted in Bechtel Jacobs Company LLC-managed and Untied Statues Enrichment Corporation (USEC)-leased facilities. This work has been summarized in the subject document.



C. L. Owens and J. H. Key of the Paducah Paper, Allied-Industrial, Chemical & Energy Workers International Union each have requested a copy. In addition, J. D. Jackson, H. J. Monroe, G. L. Love of DOE Oak Ridge Operations, and P. F. Wambach of DOE Headquarters also have requested copies. Additional copies have been provided to facilitate distribution to these interested parties.

If you have any questions or require further information, please contact Larry Payne of my staff at (270) 441-5040.

Sincerely,

for Gordon L. Dover
Paducah Manager of Projects

GLD:LDP:bar

Enclosure: As stated

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# Beryllium Sampling Project at the Paducah Gaseous Diffusion Plant

**September 2003**

**Prepared for**

**Bechtel Jacobs Company, LLC**

**Prepared by**

**PrSM Corporation**

BJC/PAD-581

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## EXECUTIVE SUMMARY

A sampling project was designed and executed to measure beryllium in selected U.S. Department of Energy (DOE)-owned facilities at the Paducah Gaseous Diffusion Plant (PGDP). Sampling took place in Bechtel Jacobs Company, LLC (BJC)-managed and United States Enrichment Corporation (USEC)-leased facilities from May to June 2003. The project's goals were to:

1. Identify beryllium contaminated areas which may result in exposure to current workers; and
2. Complete a baseline beryllium assessment in the BJC-managed areas as required by the DOE Chronic Beryllium Disease Prevention Program, Final Rule (1). Results from a January 2002 initial assessment, described in a previous report prepared by PrSM Corporation (2), indicated that additional sampling was necessary.

Neither BJC nor USEC currently have on-going beryllium operations at PGDP. Sampling sites with confirmed or potential history of beryllium use were identified through review of available documents and interviews with current and former workers.

The methods used in this sampling project conform to the Final Rule requirements and are consistent with those employed at other DOE locations.

A total of 695 surface wipe, bulk, and air samples were collected in 11 areas at the PGDP. No air samples contained detectable beryllium. Air samples were collected during wipe and bulk sampling tasks. They represent the expected level of exposure for individuals performing tasks with a minimal disturbance of surface dust.

Beryllium in concentrations at or above the local background soil concentrations were found in 11.8% of bulk samples. Seven percent of surface wipe samples contained beryllium greater than the DOE housekeeping level (0.2 $\mu g/100cm^2$). Individual area results are discussed in Section 4. Tables of all sampling results are provided in the appendices.

Based on the facts presented in this report, it is concluded that:

1. There is no anticipated airborne exposure to beryllium when performing tasks with similar potential for disturbing surface particulate.

2. There are limited beryllium-contaminated areas within the BJC-managed facilities at the PGDP. The following areas exceed the DOE housekeeping criterion for surface contamination:
    - C-400 North Stack and Exhaust Ventilation System[1] – Interior Only
    - C-400 DMSA 400-03 – Gold Dissolver Ground Level Surfaces
    - C-400 DMSA 400-04 – Gold Room
    - C-746-A East Smelter – Elevated Surfaces, Mezzanine and Equipment
    - C-746-A West Smelter – Elevated Surfaces and Furnaces
3. Beryllium is present in limited areas within the USEC-leased facilities at the PGDP. There is no surface contamination criterion applicable to these areas. However, if the DOE criterion was applied, the evaluation of sampling results suggest the following area may be beryllium contaminated.
    - C-720 Machine Shop – Roof Exhaust Ventilation
4. There were insufficient numbers of samples to calculate a $UTL_{95,95}$ for the following USEC-leased space or equipment.
    - C-720 Gauge Shop - CNC Mill
    - C-710 Room B-11
    - C-710 B13 Tensile Test Table – Pit only
    - C-400 Building West Side- Elevated and Ground Level Surfaces (with the exception of the specific areas listed above)
5. Statistical evaluation provides confidence that these USEC-leased areas are not beryllium contaminated;
    - C-400 Building East Side
    - C-720 Gauge Shop
    - C-720 Machine Shop (with the exception of the roof exhaust ventilation)
    - C-720-C Converter Shop
    - C-720 Mezzanine Offices and Material Handling Area
6. No beryllium was detected in samples from the USEC-leased equipment listed below. The equipment is not beryllium contaminated:

[1] It is unclear if this space is BJC-managed or USEC-leased.

- C-710 B13 and B22 Tensile Test Tables – with the exception of the pit

7. The C-720 Mezzanine Offices and Material Handling Area may be two separate HCAs.

## 1.0 PURPOSE AND SCOPE

A sampling project was designed and executed to measure beryllium in selected U.S. Department of Energy (DOE)-owned facilities at the Paducah Gaseous Diffusion Plant (PGDP). Sampling took place in Bechtel Jacobs Company, LLC (BJC)-managed and United States Enrichment Corporation (USEC)-leased facilities from May to June 2003. The project's goals were to:

1. Identify beryllium contaminated areas which may result in exposure to current workers; and
2. Complete a baseline beryllium assessment in the BJC-managed areas as required by the DOE Chronic Beryllium Disease Prevention Program, Final Rule (1). Results from a January 2002 initial assessment, described in a previous report prepared by PrSM Corporation (2), indicated that additional sampling was necessary.

Sampling efforts were limited to areas discussed in this report.

## 2.0 BACKGROUND

The Final Rule requires a baseline beryllium inventory for all DOE operations or activities that involve present or past potential beryllium exposure. If the baseline inventory establishes the presence of beryllium, the responsible employer must conduct a hazard assessment.

The Final Rule does not apply to work involving beryllium in areas that are not operated for or by DOE. USEC operations and USEC-leased spaces do not fall under the DOE rule.

Neither BJC nor USEC currently have on-going beryllium operations at PGDP. Sampling sites with confirmed or potential history of beryllium use were identified through review of available documents and interviews with current and former workers. (3, 4)

The beryllium sampling assessment of building C-746-A performed by PrSM Corporation in January 2002 indicated that floor level surfaces in the East and West Smelters were not beryllium contaminated. However, the presence of low levels of beryllium prompted the recommendation that additional sampling be conducted on equipment and elevated surfaces.

## 3.0 METHODS

The methods used in this sampling project conform to the Final Rule requirements and are consistent with those employed at other DOE locations. A Certified Industrial Hygienist (CIH), with experience performing such work at other DOE and commercial facilities, planned and executed this sampling project with assistance from other qualified technical and administrative personnel.

### 3.1 Review of Current and Historical Records

The DOE "Metals Recovery Program" and "Work for Others" reports (3, 4) were consulted to determine areas where beryllium may have been used.

### 3.2 Interview of Knowledgeable Personnel

Retired and current USEC employees, a representative from the Paper and Allied Chemical and Energy Workers Local 5-550 (PACE) union representing workers at USEC, a USEC Industrial Hygienist, and BJC personnel with knowledge of the buildings were interviewed to supplement and verify the information obtained in the records review. Workers were interviewed to understand the scope of work currently performed in the buildings. The project file contains notes from interviews.

### 3.3 Documentation of Characteristics and Locations of Beryllium at the Facility

The CIH performed a preliminary walk-through of the buildings to identify locations of possible beryllium contamination. Sections of the buildings were designated as "possibly contaminated" or "assumed clean" based upon historical evidence, process knowledge, building structure factors, and/or professional judgment.

### 3.4 Rationale for Sampling

Table 3.1 summarizes the rationale for conducting beryllium sampling in each area.

**Table 3.1: Location Specific Justification for Sampling**

| Building | Location | Reason | Current Area Use | Current Be Use |
|---|---|---|---|---|
| C-710 | B11 Machine Shop | Some Copper Beryllium (CuBe) may have been machined. | Machine Shop | None |
| C-710 | B13 | Tensile test table may have been used to test parts machined in B11. | Lab | None |
| C-710 | B22 | Tensile test table present, but not believed to have been used to test parts from B11. | Lab | None |
| C-720 | Machine Shop | Historical machining of CuBe and possible beryllium parts. | Machine Shop | None |
| C-720 | Gauge Shop | May have been used to do close tolerance work on items from the main machine shop. | Machine Shop | None |
| C-720 | Gauge Shop – CNC Mill | Workers report that this mill was in an area of C-720-C where beryllium may have been machined. | Mill | None |
| C-720 | Mezzanine Offices and Material Handling Area | Supply air to office area may have come from C-720 machine shop area. | Offices | None |
| C-720-C | Converter Shop | Two CNC machines may have been used to machine beryllium or beryllium-containing materials. | | None |
| C-400 | DMSA 400-04<br>Gold Room | Used to store crucibles associated with Work for Others Program (gold recovery). | Inactive facility | None |
| C-400 | West Side including DMSA 400-03 (Gold Dissolver) | Gold from Work for Others Program was brought from the smelters for recovery in the gold dissolver. Assumed to be contaminated with beryllium. | Plant Laundry, Chemical Processes | None |
| C-400 | East Side including DMSA 400-05 (Pulverizer) | The pulverizer was used to pulverize $UF_4$. Based on USEC employee concerns, this area may have been used to pulverize other metals or materials contaminated with beryllium. | Cylinder Wash, Dip Tanks, Storage, Break Area | None |
| C-746-A | East Smelter | Additional sampling required to complete baseline beryllium inventory. | Inactive facility with some drum storage | None |
| C-746-A | West Smelter | Additional sampling required to complete baseline beryllium inventory. | Inactive facility | None |

### 3.5 Sampling Strategy

The number of samples collected and sample locations were established using a statistically-based sampling strategy that was reviewed and commented on by a PACE union representative, CIHs representing USEC and BJC, and a DOE Industrial Hygienist. The sampling strategy is provided as Appendix A.

Samples were collected from areas believed to be "possibly contaminated" using a judgmental sampling strategy. This strategy focuses on collecting samples from worst-case sample locations, that is, those areas most likely to harbor contamination. The intent was to find beryllium by selecting the locations, based on the judgment of the industrial hygienist, where contamination would most likely exist (i.e., point of operation on machines and horizontal surfaces which had presumably not been disturbed). This sampling technique required a sample size of 29 samples per area prove the hypothesis of contamination.

Samples were collected from areas that were "assumed clean" using a stratified-random sampling strategy. Building structural characteristics, layout of rooms and equipment, and surface accessibility were considered before dividing the area into sampling strata such as equipment, ground level surfaces, elevated surfaces, etc. Sample locations were then selected from within each strata, using random techniques to the extent practical. A total of 59 samples were planned for each strata.

### 3.6 Comparison to Standards

#### 3.6.1 Air

The standard for evaluation of personal breathing zone samples is 0.2 micrograms beryllium per cubic meters of air reported as an 8-hour time-weighted average (0.2 $\mu g/m^3$ 8-TWA). This is the Final Rule action level for airborne beryllium exposure. The individuals performing this work were covered under the Final Rule. The Occupational Safety and Health Administration (OSHA) Permissible Exposure Limit (PEL) and the American Conference of Governmental Industrial Hygienists (ACGIH) Threshold Limit Value (TLV) for beryllium is 2 $\mu g/m^3$ 8-TWA. There is no standard for area air samples.

#### 3.6.2 Bulk

Bulk samples were compared to the range of levels of beryllium in the local soil, 0.6 to 1.3 milligrams beryllium per kilogram of sample (mg/kg). (5) This level is referred to in this report as the "background level." It is not linked to a regulatory standard.

#### 3.6.3 Wipe

Wipe samples were compared to the levels for beryllium contamination described in the Final Rule for release of equipment to the general public or to non-beryllium processing areas in other DOE facilities, 0.2 $\mu g/100cm^2$. Although this limit is most correctly applied to equipment, it has also been implemented as a housekeeping level for non-beryllium operations areas. Areas not used for beryllium processing are measured against this housekeeping level to establish the presence of beryllium contamination.

USEC-leased areas and operations are not covered by the Final Rule. There is no applicable standard for surface beryllium contamination. However, to provide a criterion for comparison, the results in this report will be treated as if the Final Rule applies.

### 3.7 Statistical Validation

The statistical test selected for this project was the Upper Tolerance Level 95%, 95% ($UTL_{95,95}$), an upper confidence limit calculated for a distribution percentile. The $UTL_{95,95}$ is a conservative test for contamination and examines the upper tail of a distribution (i.e. the greatest 5%) rather than examining an "average" level or mean. This test has been applied on numerous beryllium characterization surveys in the DOE complex to determine if specific areas should be considered contaminated with beryllium. The contamination limit applied to this test was the DOE housekeeping level, 0.2 $\mu g/100cm^2$. When this test is applied, the outcome enables one to state: "we are 95% confident that 95% of the surfaces do/do not have beryllium contamination on surfaces that exceeds 0.2 $\mu g/100cm^2$."

Because the true distribution of the data was unknown prior to sampling, assumptions were made in the development of the sampling strategy. One assumption is that the data is lognormally distributed. It has been repeatedly proven that environmental data tends to be lognormally distributed. (6) However, when a small number of samples are collected or a large number of sample results are below the laboratory limit of detection, it may not be possible to validate this assumption. This forces the use of non-parametric rather than parametric statistics. Non-parametric statistics require much larger samples sizes to be valid. Such was the case with some of these data sets. The true underlying distribution of the data could not be demonstrated and non-parametric statistics were used. Unfortunately, that meant that there were not enough data points to calculate the $UTL_{95,95}$ for some of the areas. Additional sampling is recommended for these areas.

A second assumption made prior to sampling was that contamination levels in certain areas were homogeneous (or at least similar). The phrase Homogeneous Contamination Areas (HCA) is used to describe an area with characteristics that would suggest that contamination levels should be similar.

These characteristics can include (but are not limited to) similar processes, similar controls, physical layout, types of materials used and quantities of materials used. HCAs were established in the sampling strategy for this project. However, the sampling results indicated that some areas within HCAs did not contain similar contamination levels. This forced the re-assessment of HCA definitions. In some cases, the results supported combining several areas into one larger HCA to provide greater statistical power. The inability to validate HCA assumptions further complicated statistical analysis.

Finally, statistical analysis is severely limited when a significant portion (>30%) of the data set is censored. That is, the true value is unknown because the result is less than the analytical LOD or (i.e. left-censored) or the concentration is so high it can't be accurately measured (i.e. right-censored). This data set was left-censored and was the biggest reason that that the true underlying distribution of the data could not be determined.

Because of these factors, a complicated series of decisions were applied to the data in order to determine what valid statistical tests could be applied. Appendix B contains a flow diagram illustrating the logic used to determine the statistical test used for each data set.

### 3.8 Sample Documentation

Sample characteristics and locations are described as part of the sampling documentation. Sample data sheets were created for each unique sample and are maintained in the project file. Locations of surface wipe, air, and bulk samples were marked on drawings of each building. Sample location maps are provided in the Appendices.

Each field team member maintained a project logbook. Logbooks were used to document daily field activities. Sampling strategy deviations and unusual or unexpected conditions are noted on the sample data sheets or in the project logbooks.

### 3.9 Sampling and Analytical Procedures

Technical procedures consistent with current best-industry practices (e.g., National Institute for Occupational Safety and Health (NIOSH) methods and American Society for Testing and Materials procedures) were used for collecting samples. See Appendix C for Sampling and Analytical Methods.

Some specific sampling practices for surface wipe samples were:

- Samples were collected on horizontal surfaces;

- Samples were collected using a 100 $cm^2$ template where possible;
- The template was decontaminated between samples;
- Gloves were changed between each sample; and
- Smear tabs (SKC, Inc. p/n 225-24) moistened with de-ionized water were used.

Samples were analyzed at the PGDP USEC Analytical Laboratory which is American Industrial Hygiene Association (AIHA) accredited for metals analysis. An aggressive digestion technique was utilized to ensure that all forms of beryllium would be detected in the analytical process.

### 3.10 Limitations

Limitations of the data include:

- Interior surfaces of equipment were not sampled unless otherwise noted.
- The pit area of the C-746-A Building East Smelter was inaccessible.
- Sampling on elevated surfaces was limited to those areas accessible by the equipment used (ladders, aerial lift and bridge cranes).
- Many results were below the limit of detection. While we know that these results do not exceed the LOD, we do not know the true value. The true value lies between zero and the LOD. Sample results that were less than the LOD were assigned a value equal to the LOD for statistical evaluation.
- The sample size for some areas limited the statistical analysis. See Section 3.7 Statistical Validation.
- Where a judgmental sampling strategy was employed, conclusions should be drawn carefully about contamination on surfaces that were not sampled. One may choose (or not) to assume that that contamination on un-sampled surfaces is similar to that on sampled surfaces.
- The selected sampling strategies (i.e. judgmental and stratified random) have a greater potential to introduce sampling bias than does a purely random sampling strategy. A truly random sampling strategy is difficult to execute. That is a fundamental trade-off that was considered when factoring cost and schedule into the project.
- Bulk and wipe sample results represent only existing contamination levels. They do not provide information on past contamination levels. Results of air sampling only represent activities with similar potential for disturbing surface contamination. They do not estimate historical exposure potential.

## 4.0 RESULTS

A total of 695 surface wipe, bulk, and air samples were collected in 11 areas at the PGDP. No air samples contained detectable beryllium. Results of air sampling are presented in Appendix D. Air samples were collected during wipe and bulk sampling tasks. They represent the expected level of exposure for tasks where a minimal disturbance of surface particulate occurs.

Beryllium in concentrations at or above the local background soil concentrations was found in 11.8% of bulk samples. Seven percent of surface wipe samples contained beryllium greater than the DOE housekeeping level (0.2 $\mu g/100cm^2$). Individual area results are discussed throughout Section 4.0. Tables of all sampling results are provided in the appendices.

Table 4.1 presents the statistical analysis results of each area and its status with respect to the DOE housekeeping level, as appropriate.

**Table 4.1: DOE Housekeeping Level Status by Location**

| Location | Specific Area | $UTL_{95,95}$ ($\mu g/100cm^2$) | DOE Housekeeping Level Status |
|---|---|---|---|
| C-710 | Room B11 | 0.015 | Not Exceeded |
| C-710 | Room B13 - Tensile Test Table | Not Calculated‡ | - |
| C-710 | Room B22 - Tensile Test Table | Not Calculated‡ | - |
| C-720 | Mezzanine Offices | 0.123§ | Not Exceeded |
| C-400 | East Side | 0.103 | Not Exceeded |
| C-400 | West Side – Elevated and Ground Level Surfaces (including DMSA 400-03 Elevated Surfaces) | 0.05§ | Not Exceeded |
| C-400 | West Side - North Stack Exhaust Ventilation System | 4.041 | Exceeds |
| C-400 DMSA 400-03 | Ground Level | 0.976 | Exceeds |
| C-400 DMSA 400-04 | Entire Room | Not Calculated | Exceeds |
| C-720 Gauge Shop, Machine Shop, and C-720-C Converter Shop | Elevated Surfaces, Ground Level Surfaces, Machines and Exhaust Ventilation (with the exception of the Machine Shop Exhaust | 0.127 | Not Exceeded |
| C-720 Gauge Shop | CNC Mill | Not Calculated‡ | - |
| C-720 Machine Shop | Roof Exhaust Ventilation | Not Calculated‡ | Exceeds |
| C-746-A East Smelter | All Elevated Surfaces | 1.472 | Exceeds |
| C-746-A East Smelter | Mezzanine | 0.423 | Exceeds |
| C-746-A East Smelter | Equipment | 0.24 | Exceeds |
| C-746-A West Smelter | All Elevated Surfaces | Not Calculated | Exceeds |
| C-746-A West Smelter | Furnaces | 4.017 | Exceeds |

‡ The number of samples was less than the minimum number required, 6, to use this test.
§ A $UTL_{95,95}$ could not be calculated, an alternative UTL was calculated using non-parametric statistics. See Section 4.0 for details.

Results in this section are organized by building and by discrete areas within the building so that areas can be assessed independently of each other.

## 4.1 C-710 Building

Three areas were assessed for beryllium contamination in building C-710: rooms B11, B13 and B22. These areas are USEC-leased space.

### 4.1.1 C-710 Building – Room B11

Samples were collected on elevated surfaces, ground-level surfaces, the exhaust system, and machines. Samples from the exhaust ventilation system were collected on the grill covering the ductwork entry. Samples from elevated surfaces and the exhaust ventilation system were collected using a ladder.

The room was designated as "possibly contaminated" because the initial walkthrough suggested that beryllium might have been machined in the room. A judgmental sampling strategy was employed. Sample locations included machines (bandsaw, Bridgeport Mill, Leco cut-off machine, Wilton belt sander, Delta pedestal grinders (2), Darex drill sharpener, Clausing drill press, Hardinge lathe), floor, shelves, tool boxes, light fixtures, speakers, overhead piping and conduit, and exhaust system grill.

None of the wipe samples exceeded the DOE housekeeping criterion. The large number of results less than the LOD required the use of non-parametric statistics. A $UTL_{95,95}$ could not be calculated. Instead non-parametric statistics supported the reporting of a $UTL_{97,90}$ which can be stated as: "we are 97% confident that 90% of surfaces are contaminated less than the LOD (0.015 $\mu g/100cm^2$)".

See Appendix F-1 and Table 4.2.

**Table 4.2: Beryllium Sampling Results for C-710 Building - Room B11**

| Location | Type | Number Collected | Number > LOD | % > LOD | Number > Standard | % > Standard | $UTL_{97,90}$ |
|---|---|---|---|---|---|---|---|
| Room B11 | Air | 2 | 0 | 0 | 0 | 0 | - |
| | Bulk | 4 | 0 | 0 | 0 | 0 | - |
| | Wipe | 47 | 0 | 0 | 0 | 0 | 0.015 |

### 4.1.2 C-710 Building – Rooms B13 and B22

In these rooms, only the tensile test tables were tested for beryllium contamination.

None of the wipe samples exceeded the DOE housekeeping criterion. Due to the small sample size statistics were not calculated.

Suitable bulk material was found for only one bulk sample location: the pit of the tensile test table in room B13. Beryllium was measured at a concentration of 3.61 mg/kg, approximately 3 to 6 times the background level). The pit area was mostly free of solid residue and had only a light layer of oil. The bulk sample consisted of coarse particulate material and metal chips coated with oil. See Appendices F-2, F-3 and Table 4.3.

**Table 4.3: Beryllium Sampling Results for C-710 Building - Rooms B13 and B22**

| Location | Type | Number Collected | Number > LOD | % > LOD | Number > Standard | % > Standard |
|---|---|---|---|---|---|---|
| Room B13 | Air | 0 | - | - | - | - |
| | Bulk | 1 | 1 | 100 | 1 | 100 |
| | Wipe | 4 | 0 | 0 | 0 | 0 |
| Room B22 | Air | 0 | - | - | - | - |
| | Bulk | 0 | - | - | - | - |
| | Wipe | 4 | 0 | 0 | 0 | 0 |

## 4.2 C-720 Building – Mezzanine Offices and Material Handling Area

The mezzanine area of building C-720 is used as office space for approximately 50 USEC employees. This area was identified for sampling because it could not be confirmed that the supply air to the offices did not come from the adjacent machine shop, an area of possible beryllium contamination.

The mezzanine area was designated "assumed clean" and a stratified-random sampling strategy was used. Sampling was limited to those areas that were readily accessible to employees in the workspaces: desks, floors, windowsills, door casings, bookshelves, and other horizontal surfaces. No elevated samples were collected. Suitable material was not found for bulk samples.

Air samples were collected during the sampling effort and on a subsequent day during normal office activities.

None of the wipe samples exceeded the DOE housekeeping criteria. The highest level of beryllium, 0.123 $\mu g/100cm^2$ was collected on a junction box in the material handling area. A second sample

collected in the area also contained beryllium but was less than the limit of quantitation. This area can open to the walkway below to hoist equipment.

The large number of results less than the LOD required the use of non-parametric statistics. A $UTL_{95,95}$ was calculated and can be stated as: "we are 95% confident that 95% of surfaces are contaminated less than the 0.123 µg/100cm$^2$". See Appendix G and Table 4.4.

**Table 4.4: Beryllium Sampling Results for C-720 Building - Mezzanine Offices and Material Handling Area**

| Location | Type | Number Collected | Number > LOD | % > LOD | Number > Standard | % > Standard | $UTL_{95,95}$ |
|---|---|---|---|---|---|---|---|
| C-720 Building Mezzanine Offices | Air | 5 | 0 | 0 | 0 | 0 | - |
| | Bulk | 0 | - | - | - | - | - |
| | Wipe | 62 | 9 | 14.5 | 0 | 0 | 0.123 |

## 4.3 C-400 Building – East Side

The east side of the C-400 building includes a set of dip tanks, a cylinder wash area, storage, a break room, and a pulverizer unit. The pulverizer is administratively controlled by BJC as DMSA 400-05. The rest of the east side, with the exception of other DMSAs, is leased to USEC. See Appendix F-1.

This side of the building was designated "assumed clean." Stratified-random sample locations were selected throughout the building on the elevated and ground level surfaces and the exterior of the pulverizer. Samples were collected from elevated surfaces using an aerial lift and included light fixtures, crane rails, I-beams and other structural building components, roll-up door parts, conduit, junction boxes, and transformers.

None of the wipe samples exceeded the DOE housekeeping criterion. The large number of results less than the LOD required the use of non-parametric statistics. A $UTL_{95,95}$ was calculated and can be stated as: "we are 95% confident that 95% of surfaces are contaminated less than 0.103 µg/100cm$^2$". See Appendix H and Table 4.5.

**Table 4.5: Beryllium Sampling Results for C-400 Building - East Side**

| Location | Type | Number Collected | Number > LOD | % > LOD | Number > Standard | % > Standard | $UTL_{95,95}$ |
|---|---|---|---|---|---|---|---|
| C-400 Building East Side | Air | 6 | 0 | 0 | 0 | 0 | - |
| | Bulk | 6 | 0 | 0 | 0 | 0 | - |
| | Wipe | 62 | 27 | 44 | 0 | 0 | 0.103 |

## 4.4 C-400 Building - West Side

The west side of the C-400 building, at one time, housed a gold recovery operation. The locations of these operations are now administratively controlled by BJC as DMSA 400-03 and DMSA 400-04. The rest of the west side is leased to USEC. Sampling in DMSA 400-03, gold dissolver, and DMSA 400-04, the gold room, is discussed in Sections 4.5 and 4.6 respectively. The west side was designated as "possibly contaminated" and a judgmental sampling strategy was developed. See Appendix I-1.

### 4.4.1 C-400 Building West Side – Ground Level and Elevated Surfaces

None of the wipe samples exceeded the DOE housekeeping criterion. The large number of results less than the LOD required the use of non-parametric statistics. A $UTL_{95,95}$ could not be calculated. Non-parametric statistics supported the reporting of a $UTL_{99,75}$ which can be stated as: "we are 99% confident that 75% of surfaces are contaminated less than 0.05 $\mu g/100cm^2$". See Appendix I-2 and Table 4.6.

**Table 4.6: Beryllium Sampling Results for C-400 Building West Side - Ground Level and Elevated Surfaces**

| Location | Type | Number Collected | Number > LOD | % > LOD | Number > Standard | % > Standard | $UTL_{99,75}$ |
|---|---|---|---|---|---|---|---|
| C-400 Building West Side Ground and Elevated Surfaces | Air | 3 | 0 | 0 | 0 | 0 | - |
| | Bulk | 4 | 0 | 0 | 0 | 0 | - |
| | Wipe | 24 | 3 | 12.5 | 0 | 0 | 0.05 |

### 4.4.2 C-400 Building West Side – North Stack Exhaust Ventilation System

The north stack system is a local exhaust ventilation system that serves the gold dissolver unit, some tanks, and other process equipment north of the gold dissolver. The system is currently operational. It is unclear if they system is BJC-managed or USEC-leased space. Samples were collected only on the system interior at the dust collector; no samples were collected on ductwork, the fan, or the stack.

This location exceeded the DOE housekeeping criterion for beryllium contamination. A $UTL_{95,95}$ was calculated and can be stated as: "we are 95% confident that 95% of surfaces are contaminated less than 4.041 µg/100cm$^2$". See Appendix I-3 and Table 4.7.

**Table 4.7: Beryllium Sampling Results for C-400 Building West Side - North Stack Exhaust Ventilation System**

| Location | Type | Number Collected | Number > LOD | % > LOD | Number > Standard | % > Standard | $UTL_{95,95}$ |
|---|---|---|---|---|---|---|---|
| C-400 Building West Side – North Stack Exhaust Ventilation | Air | 1 | 0 | 0 | 0 | 0 | - |
| | Bulk | 0 | - | - | - | - | - |
| | Wipe | 10 | 9 | 90 | 2 | 20 | 4.041 |

### 4.5 DMSA 400-03 – Gold Dissolver

A single bulk sample collected on top of a control panel in the DMSA contained beryllium in a concentration of 1.22 mg/kg. This is within the background beryllium concentration range.

A single sample, taken on process piping, was greater than the DOE housekeeping criterion. A $UTL_{95,95}$ of 0.976 µg/100cm$^2$ was calculated for this sample set. The $UTL_{95,95}$ result for wipe samples can be stated as: "we are 95% certain that 95% of the surfaces do not exceed 0.976 µg/100cm$^2$. See Appendix I-4 and Table 4.8.

Surface wipe sampling conducted above the DMSA on elevated surfaces indicated no detectable levels of beryllium. These four samples are included with those discussed in Section 4.4.1: C-400 Building West Side Ground Level and Elevated Surfaces.

**Table 4.8: Beryllium Sampling Results for DMSA 400-03 - Gold Dissolver**

| Location | Type | Number Collected | Number > LOD | % > LOD | Number > Standard | % > Standard | $UTL_{95,95}$ |
|---|---|---|---|---|---|---|---|
| DMSA 400-03 – Gold Dissolver | Air | 0 | - | - | - | - | - |
| | Bulk | 1 | 1 | 100 | 0 | 0 | - |
| | Wipe | 6 | 6 | 100 | 1 | 16.7 | 0.976 |

## 4.6 DMSA 400-04 – Gold Room

The gold room, a separate room within C400, is administratively controlled by BJC as DMSA 400-04.

One of four bulk samples contained a detectable level of beryllium. The sample, collected from a miscellaneous horizontal surface, possibly the floor, contained 1.28 mg/kg beryllium. This is within the background range of 0.6 to 1.3 mg/kg.

A single sample greater than the DOE housekeeping criterion was collected on a shelf immediately inside the room. The result of this sample was 0.695 $\mu g/100cm^2$. Because six of eleven samples results were <LOD, a lognormal distribution could not be confirmed and valid statistics could not be calculated. It is estimated that an additional 48 wipe samples must be collected to perform the calculations. However, because one result was measured at 0.695 $\mu g/100cm^2$, the $UTL_{95,95}$ would still likely exceed the DOE housekeeping criterion. It is concluded there is no value in additional sampling until this area has been decontaminated. Further discussion is provided in Section 5.0. See Appendix J and Table 4.9.

**Table 4.9: Beryllium Sampling Results for DMSA 400-04 - Gold Room**

| Location | Type | Number Collected | Number > LOD | % > LOD | Number > Standard | % > Standard |
|---|---|---|---|---|---|---|
| DMSA 400-04 – Gold Room | Air | 1 | 0 | 0 | 0 | 0 |
| | Bulk | 4 | 1 | 25 | 0 | 0 |
| | Wipe | 11 | 5 | 45 | 1 | 9.1 |

## 4.7 C-720 Building – Gauge Shop, Machine Shop and C-720-C Converter Shop

These three areas were originally separate HCAs in the original sampling strategy. Each area is believed to have been used to machine beryllium and was designated "possibly contaminated". Because results of

the sampling in these areas were similar, the three were combined into one HCA to provide greater statistical power. One area in the C-720 Machine Shop was not included in this final HCA. It is the machine shop exhaust ventilation and is discussed in Section 4.9.2. Discussions of the characteristics and remarkable results of each area are presented below. The results for the HCA are presented in Section 4.7.4.

### 4.7.1 Gauge Shop

The gauge shop is an active machine shop adjacent to the main machine shop in C-720. It is a separate room within C-720 and is leased to USEC.

Samples were collected on elevated surfaces (speaker, light fixture, ceiling ledges, hoist rail, fire protection pipes, exit sign, conduit junction box), exhaust ventilation grills, a CNC mill, and ground level surfaces including the floor. The exhaust ventilation sampling was limited to the accessible surfaces, which included the grill covering the ductwork and about 3 – 4 inches into the ductwork. See Appendix K-1 and Table 4.10.

A single wipe sample showed beryllium contamination in excess of the DOE housekeeping level. This sample, measured at 0.275 $\mu g/100cm^2$, was collected from the floor along the north wall of the room. Other samples in the room did not indicate elevated levels of beryllium.

### 4.7.2 Machine Shop

The machine shop is leased to USEC. The sampling strategy was designed to target ground level and elevated surfaces with potential for residual beryllium contamination. In addition, samples were collected on each of the machines that were known or suspected of being used to machine beryllium and from the machine shop exhaust ventilation system. See Appendix K-2.

**Machine Shop Elevated Surfaces**

Information from employee interviews indicated that the ceiling area had been re-painted. The surfaces had been blown down with compressed air to remove any particulate prior to painting. Visual observation confirmed that surfaces within approximately 6 feet of the ceiling had been painted white and there was evidence of overspray on many light fixtures.

The sampling effort on elevated surfaces targeted areas likely to have been undisturbed during painting activities. These areas were accessed from the platforms of the bridge cranes. Sample locations above

machines associated with beryllium use were selected. Some light fixtures were sampled to provide information on the exposure potential for workers who may perform re-lamping in the building. The majority of samples, however, were collected on surfaces that appeared to have not been disturbed during the painting. Surface wipe samples and bulk samples were collected on steam water lines, cranes, crane rails, light fixtures, and cross braces and column ledges that had not been repainted. Of these, 4 of 22 or 18% of samples were collected on surfaces that may have been affected by the painting process.

None of the wipe samples from elevated surfaces were above the DOE housekeeping criterion. See Appendix K-3 and Table 4.10.

**Machine Shop Ground Level Surfaces**

Locations adjacent to machines that may have been used to machine beryllium were selected for sampling. Ground level samples were collected on the floor, worktables, ledges, power cabinets, and column bases.

One surface wipe sample was greater than the DOE housekeeping level. It was collected on top of a 480-volt cabinet between columns F-12 and F-13 and was measured at 0.273 $\mu g/100cm^2$. A duplicate sample, taken adjacent to the first sample, was measured at 0.198 $\mu g/100cm^2$. See Appendix K-4 and Table 4.10.

**Machine Shop Machines**

Based on interviews with current and former workers the following machines were identified as having possibly been used to machine beryllium:

- LeBlond Lathe (L-40)
- Hardinge Lathe (DOE # C75152)
- Carlton Drill Press (D-1)
- Blue Cincinnati Milacron CNC
- Cincinnati Gilbert 5-Axis Mill (M-5)
- Cincinnati Milacron Mill (M-17)
- LeBlond Lathe (L-41)
- Pratt and Whitney Mill (D-5)
- LeBlond CNC Lathe (L-99)
- Verson Press

Three to four samples were collected per machine. Sample locations included the point of operation, or as close to it as possible, machining fluid trays, fluid backsplashes, channels in worktables, tops of machines, or other surfaces that appeared have a build-up of particulate. In locations where suitable material was found, bulk samples were also collected.

One bulk sample, associated with the Verson Press, contained beryllium in a concentration of 0.653 mg/kg, within the normal background range. See Appendix K-5 and Table 4.10.

### 4.7.3 C-720-C Building – Converter Shop

The converter shop is leased to USEC. Worker interviews presented conflicting information regarding age of the settled material on the elevated surfaces. One worker stated that the ceiling had been painted and particulate blown off surfaces at the same time the C-720 machine shop had been painted. Another worker stated that the ceiling had not been painted. Observation during the sampling suggested that the ceiling had not been painted. There was no evidence of overspray on light fixtures and other surfaces as there had been in the C-720 machine shop. Samples on elevated surfaces were collected on cross-braces, I-beams, light fixtures, beams, the crane, and crane rail. Sampling was conducted from the platform of one of the bridge cranes.

Ground level sampling was concentrated around the location where the CNC machines were once positioned. The CNC machines had since been moved out of the converter shop. One, LeBlond CNC Lathe (L-99), was moved to the C-720 Machine Shop and was sampled as part of that group of machines. The other CNC machine may have been sent to Oak Ridge.

Exhaust system sampling was conducted on three of the floor exhaust units. This sampling was limited to the grills on two of the units. The fan and belt access was open for servicing on the third unit; bulk and wipe samples were collected in this area.

None of the wipe samples exceeded the DOE housekeeping criterion. See Appendix K-6 and Table 4.10.

### 4.7.4 Results

A UTL95,95 was calculated for this HCA. The result can be stated as: we are 95% confident that 95% of the surfaces are contaminated less than 0.127 μg/100cm$^2$.

**Table 4.10: Beryllium Sampling Results for C-720 Building- Gauge Shop, Machine Shop and C-720-C Building - Converter Shop**

| Location | Type | Number Collected | Number > LOD | % > LOD | Number > Standard | % > Standard | $UTL_{95,95}$ |
|---|---|---|---|---|---|---|---|
| C-720 Gauge Shop, Machine Shop and C-720-C Converter Shop | Air | 9 | 0 | 0 | 0 | 0 | - |
| | Bulk | 20 | 2 | 10 | 0 | 0 | - |
| | Wipe | 154 | 83 | 54 | 2 | 1 | 0.127 |

## 4.8 C-720 Building – Gauge Shop CNC Mill

None of the wipe samples collected exceeded the DOE housekeeping criterion. Three wipe samples were collected on this machine. Beryllium was detected in all three samples. The sample size was too small to calculate a set of statistics. Results were 0.023, 0.023 and 0.148μg/100cm$^2$. See Appendix K-7 and Table 4.11.

**Table 4.11: Beryllium Sampling Results for C-720 Building - Gauge Shop CNC Mill**

| Location | Type | Number Collected | Number > LOD | % > LOD | Number > Standard | % > Standard |
|---|---|---|---|---|---|---|
| C-720 Gauge Shop – CNC Mill | Wipe | 3 | 3 | 100 | 0 | 0 |

## 4.9 C-720 Building – Machine Shop Exhaust Ventilation

No local exhaust ventilation system serves the machine shop. Runs of circular ductwork that may have been part of such a system have been removed and capped off near the building ceiling. The only exhaust ventilation identified were two roof fans, labeled 720-061 and 720-059, located over the machine shop. A third system, labeled 720-002, serving the east end of the building, including a pit area, was also identified. It had local exhaust ventilation drops running near machine shop activities.

Wipe samples were collected on the fan blades and fan housings on the roof. On system 720-002, a sample was also collected from the ductwork on the roof. There was a thick coating of particulate on the fan blades. In some cases, it was not possible to sample 100 cm$^2$ without risking loss of sample. The

actual sample size was estimated, noted on the data sheet, and a correction factor applied when reporting the sample results.

All three of the systems sampled exceeded the DOE housekeeping criteria on at least one sample. Due to the small number of samples collected in each fan system, statistics were not calculated. See Appendix K-8 and Table 4.12.

**Table 4.12: Beryllium Sampling Results for C-720 Building - Machine Shop Exhaust Ventilation**

| Location | Type | Number Collected | Number > LOD | % > LOD | Number > Standard | % > Standard |
|---|---|---|---|---|---|---|
| C-720 Machine Shop – Exhaust Ventilation | Air | 1 | 0 | 0 | 0 | 0 |
| | Bulk | 0 | - | - | - | - |
| | Wipe | 9 | 9 | 100 | 6 | 67 |

## 4.10 C-746-A Building – East Smelter

The East Smelter is BJC-managed. The sampling strategy was designed to determine if elevated surfaces were contaminated and if equipment or other moveable items might be contaminated. Sampling was divided into four locations:

- Elevated surfaces
- Mezzanine
- Equipment associated with the Calciner
- Equipment stored in the northwest corner of the building

Upon review of the data, the two areas of equipment were combined to form one HCA: "C-746-A East Smelter Equipment". See Section 4.10.3.

One area identified for sampling in the previous beryllium sampling report was the pit associated with the Calciner. The stairway entering this pit has been closed making the pit inaccessible. Some samples were taken along the top of the pit. These samples are included in Section 4.10.3, Equipment.

Beryllium was not detected in any of the air samples collected in the east smelter. See Appendix L-1.

### 4.10.1 C-746-A Building – East Smelter Elevated Surfaces

Nine of 31 surface wipe samples (29%) exceeded the DOE housekeeping criterion. The $UTL_{95,95}$ was calculated to be 1.472 μg/100cm$^2$. The $UTL_{95,95}$ result can be stated as: "we are 95% certain that 95% of the surfaces do not exceed 1.472 μg/100cm$^2$." See Appendix L-2 and Table 4.13.

**Table 4.13: Beryllium Sampling Results for C-746A Building - East Smelter Elevated Surfaces**

| Location | Type | Number Collected | Number > LOD | % > LOD | Number > Standard | % > Standard | $UTL_{95,95}$ |
|---|---|---|---|---|---|---|---|
| C-746-A East Smelter – Elevated Surfaces | Air | 3 | 0 | 0 | 0 | 0 | - |
| | Bulk | 3 | 2 | 67 | 1 | 33 | - |
| | Wipe | 31 | 28 | 90 | 9 | 29 | 1.472 |

### 4.10.2 C-746-A Building – East Smelter Mezzanine Area

The mezzanine area is located in the southeast corner of the building. It includes a control room, a working platform that is used to access to a large crucible, and a room below which houses the body of the crucible. A judgmental sampling strategy was employed.

None of the samples exceeded the DOE release criteria. A UTL 95,95 was calculated for this sample set. The result can be stated as: "we are 95% confident that 95% of surfaces are contaminated at less than 0.423 μg/100cm$^2$". See Appendix L-3 and Table 4.14.

**Table 4.14: Beryllium Sampling Results for C-746A Building - East Smelter Mezzanine Area**

| Location | Type | Number Collected | Number > LOD | % > LOD | Number > Standard | % > Standard | $UTL_{95,95}$ |
|---|---|---|---|---|---|---|---|
| C-746-A East Smelter – Mezzanine Area | Air | 1 | 0 | 0 | 0 | 0 | - |
| | Bulk | 4 | 1 | 25 | 0 | 0 | - |
| | Wipe | 20 | 18 | 90 | 0 | 0 | 0.423 |

### 4.10.3 C-746-A Building – East Smelter Equipment

Sampling was conducted to determine if equipment should be decontaminated, labeled, or surveyed for beryllium contamination upon removal from the facility. Wipe samples were collected on a railing,

heating unit, welder, control panel, tube furnace, dust collector, belt guard, dryer, pots, molds, material elevator, vacuum crane, tank, steel pipe, cooler pump, hopper, and the pit all near the calciner and metal totes and miscellaneous equipment stored in the northwest side of the building.

Three of the 78 samples exceeded the DOE housekeeping criteria. Two of these samples were collected on the surface of molds and the third was collected on an unspecified piece of equipment in the northwest corner. Beryllium was detected in most of the surface wipe samples. A $UTL_{95,95}$ was calculated for this sample set. The result can be stated as: "we are 95% confident that 95% of surfaces are contaminated less than 0.24 $\mu g/100cm^2$.

A single bulk sample from a mold surface had measurable beryllium contamination. The result was 0.685 mg/kg, within the background level for beryllium. See Appendix L-4 and Table 4.15.

**Table 4.15: Beryllium Sampling Results for C-746A Building - East Smelter Equipment**

| Location | Type | Number Collected | Number > LOD | % > LOD | Number > Standard | % > Standard | $UTL_{95,95}$ |
|---|---|---|---|---|---|---|---|
| C-746-A East Smelter Equipment | Air | 2 | 0 | 0 | 0 | 0 | - |
| | Bulk | 12 | 2 | 17 | 0 | 0 | - |
| | Wipe | 78 | 70 | 90 | 3 | 4 | 0.24 |

### 4.11 C-746-A Building – West Smelter

The West Smelter is BJC-managed. This area was identified for additional sampling to assess beryllium contamination on elevated surfaces (2). The report also recommended surface sampling on furnaces. See Appendix M-1.

#### 4.11.1 C-746-A Building – West Smelter Elevated Surfaces

Elevated surfaces sampled in the west smelter were conduit, fire protection pipes, top of office, top of change room, I-beams, and light fixtures.

Thirteen of the 31 surface wipe samples (42%) were greater than the DOE housekeeping criterion. A lognormal distribution could not be confirmed and valid statistics could not be calculated. It is estimated that an additional 28 wipe samples must be collected to perform the calculations. Because 42% of the

results were greater than the DOE housekeeping criterion, it is concluded there is no value in additional sampling. Further discussion is provided in Section 5.0.

One of the bulk samples exceeded the background level of beryllium. The sample was measured at 2.26 mg/kg and was collected on a light fixture. See Appendix M-2 and Table 4.16.

**Table 4.16: Beryllium Sampling Results for C-746A Building – West Smelter Elevated Surfaces**

| Location | Type | Number Collected | Number > LOD | % > LOD | Number > Standard | % > Standard |
|---|---|---|---|---|---|---|
| C-746-A West Smelter – Elevated Surfaces | Air | 3 | 0 | 0 | 0 | 0 |
| | Bulk | 5 | 5 | 100 | 1 | 20 |
| | Wipe | 31 | 31 | 100 | 13 | 42 |

### 4.11.2 C-746-A Building – West Smelter Furnaces

Wipe and bulk samples were collected on the two furnaces. Six of the 12 samples (50%) exceeded the DOE housekeeping criteria. The $UTL_{95,95}$ was calculated to be 4.017 µg/100cm$^2$. The $UTL_{95,95}$ result can be stated as: "we are 95% certain that 95% of the surfaces do not exceed 4.017 µg/100cm$^2$."

Two of the 6 bulk samples exceeded the background level for beryllium. See Appendix M-3 and Table 4.17.

**Table 4.17: Beryllium Sampling Results for C-746A Building - West Smelter Furnaces**

| Location | Type | Number Collected | Number > LOD | % > LOD | Number > Standard | % > Standard | $UTL_{95,95}$ |
|---|---|---|---|---|---|---|---|
| C-746-A West Smelter – Elevated Surfaces | Air | 2 | 0 | 0 | 0 | 0 | - |
| | Bulk | 6 | 3 | 50 | 2 | 33 | - |
| | Wipe | 12 | 11 | 92 | 6 | 50 | 4.017 |

## 5.0 DISCUSSION

### 5.1 Areas with Fewer than Required Samples

The desired number of samples for comparison to the $UTL_{95,95}$ was determined in the sampling strategy. However, a review of the wipe sampling results suggested that some locations within defined sampling

areas may have had greater levels of beryllium contamination than the rest of the area. The areas that are listed in Section 6.0 Conclusions, Item 4 are those where additional sampling is recommended. A method for determining the additional number of samples required for statistical confidence in these locations is described by Mulhausen and Damiano in "A Strategy for Assessing and Managing Occupational Exposures" Table VII.1 page 267. (6). Alternately, an HCA can be evaluated using non-parametric statistics by collecting a minimum of 59 samples.

### 5.2 Beryllium in "Assumed Clean" Areas

None of the "assumed clean" areas exceeded the DOE housekeeping criterion. Detectable levels of beryllium were found in the C-400 East Side, C-720 Mezzanine Offices, and C-710 B13 Tensile Test Table. The presence of detectable levels of beryllium in "assumed clean" areas in this project might be attributed to the following:

- C-400 East Side: Materials other than $UF_4$ may have been processed in the pulverizer. Detectable levels of beryllium may have been deposited as a result of such activities. BJC has performed a thorough review of available information for this process and building. There is nothing to indicate that beryllium was used. However, the presence of low levels of beryllium suggests that a source of beryllium was present at some point.
- C-720 Mezzanine Offices and Material Handling Area. Detectable beryllium was found in the material handling area. The source of beryllium could be the machine shop, which is below and just north of the mezzanine. The levels of beryllium are similar to those found in the elevated surfaces of the machine shop area. This suggests that the area may not have been an HCA. One HCA representing the office areas and one representing the material handling area may have resulted in a more correct representation of contamination levels in the respective areas. The area will remain one HCA for this report since the $UTL_{95,95}$ is less than the DOE Housekeeping Criterion. The recommendation is made to collect additional samples in the material handling area. See Section 7.0, Recommendations.
- C-710 B13 Tensile Test Table. Wipe samples collected on this table did not have detectable levels of beryllium. The single bulk sample had beryllium in a concentration 3 to 6 times background soil concentrations. The material in this sample obtained from the pit area was described as "course particulate and metal chips". The surface of the table, where wipe samples were collected, is probably cleaned more frequently than the pit. Beryllium in the pit could remain from previous testing involving beryllium parts.

### 5.3 Beryllium Greater than the DOE Criterion in "Non-Contaminated Areas"

The C-720 Machine Shop, Gauge Shop and the C-720-C Converter Shop were combined to form one HCA. The result was that the HCA was determined to be a non-beryllium contaminated area. Two of the 154 samples were greater than the DOE criterion. They were from a 480-volt cabinet in the Machine Shop (0.273 $\mu g/100cm^2$) and the floor in the Gauge Shop (0.275 $\mu g/100cm^2$). These two samples represent a portion of the upper tail of the distribution and are not unexpected in an HCA with a history of beryllium use. Recommendations are presented in Section 7.0.

## 6.0 CONCLUSIONS

Based on the facts presented in this report, it is concluded that:

1. There is no anticipated airborne exposure to beryllium when performing tasks with similar potential for disturbing surface particulate.
2. There are limited beryllium-contaminated areas within the BJC-managed facilities at the PGDP. The following areas exceed the DOE housekeeping criterion for surface contamination:
    - C-400 North Stack and Exhaust Ventilation System[2] – Interior Only
    - C-400 DMSA 400-03 – Gold Dissolver Ground Level Surfaces
    - C-400 DMSA 400-04 – Gold Room
    - C-746-A East Smelter – Elevated Surfaces, Mezzanine and Equipment
    - C-746-A West Smelter – Elevated Surfaces and Furnaces
3. Beryllium is present in limited areas within the USEC-leased facilities at the PGDP. There is no surface contamination criterion applicable to these areas. However, if the DOE criterion was applied, the evaluation of sampling results suggest the following area may be beryllium contaminated.
    - C-720 Machine Shop – Roof Exhaust Ventilation
4. There were insufficient numbers of samples to calculate a $UTL_{95,95}$ for the following USEC-leased space or equipment.
    - C-720 Gauge Shop - CNC Mill
    - C-710 Room B-11
    - C-710 B13 Tensile Test Table – Pit only

[2] It is unclear if this space is BJC-managed or USEC-leased.

- C-400 Building West Side- Elevated and Ground Level Surfaces (with the exception of the specific areas listed above)

5. Statistical evaluation provides confidence that these USEC-leased areas are not beryllium contaminated;
    - C-400 Building East Side
    - C-720 Gauge Shop
    - C-720 Machine Shop (with the exception of the roof exhaust ventilation)
    - C-720-C Converter Shop
    - C-720 Mezzanine Offices and Material Handling Area
6. No beryllium was detected in samples from the USEC-leased equipment listed below. The equipment is not beryllium contaminated:
    - C-710 B13 and B22 Tensile Test Tables – with the exception of the pit
7. The C-720 Mezzanine Offices and Material Handling Area may be two separate HCAs.

## 7.0 RECOMMENDATIONS

BJC-managed spaces are subject to the requirements of the Final Rule and the BJC CBDPP. The recommendations are consistent with those documents. The following can be considered general recommendations for work involving beryllium-contaminated areas in BJC managed spaces.

1. A qualified industrial hygienist should evaluate exposure potential of all work in the areas.
2. Evaluate the need to apply the specific provisions of the CBDPP including medical surveillance, training, exposure minimization, air monitoring, removal of contaminated items, waste management, personal protective equipment and hygiene, and exposure history for past work in the area.
3. Control entry into the area.
4. Determine if the area should be included in the BJC CBDPP.
5. Prepare a hazard assessment to describe the current use of the areas and the potential for on-going exposure. This document will be prepared as an addendum to this report.

Recommendations for specific areas are presented in Table 7.1.

**Table 7.1: Location-Specific Recommendations for BJC-Managed Areas**

| Location | Recommendation |
|---|---|
| DMSA 400-03 Gold Dissolver | Implement general recommendations |
| DMSA 400-04 Gold Room | Implement general recommendations.<br>-or-<br>Decontaminate and re-sample the area, collecting statistically significant numbers of samples. |
| C-400 North Stack – Interior Only | Implement general recommendations. |
| C-746-A East Smelter | Implement general recommendations for work on the mezzanine and elevated surfaces<br>-and-<br>Implement a plan for removal of potentially contaminated items and equipment. |
| C-746-A West Smelter | Implement general recommendations for work on and around the furnaces and for elevated work.<br>-and-<br>Implement a plan for removal of potentially contaminated items and equipment. |
| C-400 DMSA 400-05 Pulverizer | Collect additional samples on the pulverizer interior |

The requirements of the Final Rule and the BJC CBDPP do not apply to USEC-managed facilities. However, both provide good practices for a recognized health hazard. The following general recommendations are applicable to the USEC spaces that have beryllium contamination.

1. Control access to the areas
2. Evaluate exposure potential at the task level
3. Provide information to employees on the hazard that may be present

Recommendations for specific areas are presented in Table 7.2.

**Table 7.2: Location-Specific Recommendations for USEC-Leased Areas**

| Location | Recommendation |
|---|---|
| C-710 Room B11 | Collect 12 additional samples to enable calculation of a $UTL_{95,95}$ |
| C-710 Room B13 Tensile Test Table Pit | Collect additional samples in the pit |
| C-720 Mezzanine Material Handling Area | Collect additional samples in the Material Handling Area |
| C-400 West Side | Collect 35 additional samples to enable calculation of a $UTL_{95,95}$ |
| C-720 Machine Shop – Roof Exhaust Ventilation | Implement general recommendations.<br>-or-<br>Decontaminate the equipment and re-sample. |
| C-720 Machine Shop | Implement general recommendations - control the area around the 480-volt cabinet to minimize employee contact and prevent spread of contamination.<br>-and –<br>Collect additional samples around the cabinet area to determine if adjacent areas may also be contaminated<br>-and-<br>Decontaminate areas based on sample results<br>-and-<br>Resample to verify effectiveness of decontamination |
| C-720 Gauge Shop - CNC Mill | Conduct additional sampling to obtain greater confidence in the potential for contamination on this machine. |
| C-720 Gauge Shop – Floor | Evaluate the need to clean and re-sample this area. For sample quality, samples were collected in areas where there was little potential for dust disturbance. It is not likely that normal foot traffic will disturb contaminated areas. |

## 8.0 REFERENCES:


1. Code of Federal Regulations, *Chronic Beryllium Disease Prevention Program, Final Rule;* Section 10, Part 850 (December 8, 1999).

2. PrSM Corporation, *Baseline Beryllium Inventory and Hazard Assessment for Buildings C-746A and C-746B at the Paducah Gaseous Diffusion Plant,* Paducah Gaseous Diffusion Plant. Kevil, KY (September 2001).

3. U.S. Department of Energy, Oak Ridge Operations, *Report on the Paducah Gaseous Diffusion Plant Metals Recovery Program,* (2000).

4. U.S. Department of Energy, Oak Ridge Operations, *Report on the Paducah Gaseous Diffusion Plant, "Work for Others" Program Including Weapons Support and Disposition,* (2000).

5. U.S. Department of Energy, Oak Ridge Operations, *Background Levels of Selected Radionuclides and Metals in Soils and Geologic Media at Paducah Gaseous Diffusion Plant, Paducah, KY.* Doc. # DOE/OR/07-1586 & D2.

6. A Strategy for Assessing and Managing Occupational Exposures. 2nd Edition. John Mulhausen and Joseph Damiano. American Industrial Hygiene Association. 1998.

# APPENDIX A

## Sampling Strategy PGDP Site Assessment for Beryllium Contamination

# Sampling Strategy
# PGDP Site Assessment for Beryllium Contamination

Notes:

1. This document contains proposed sampling strategy information only. Project cost and associated assumptions are included in a separate cost estimate.

2. The sampling strategy is designed to facilitate collection of a statistically valid body of data to provide a $UCL_{95,95}$. In some locations (C-400 gold room, ventilation systems) and for equipment, the sample size is smaller than required for $UCL_{95,95}$, but large enough to permit statistical analysis.

3. Personal breathing zone samples will be collected each day field sampling is performed until ten samples are collected. In each discrete area, at least one personal breathing zone sample will be collected.

4. Area air samples will be collected during one day of field sampling in each location.

5. Bulk samples will be collected if suitable material is found. Bulk samples must contain at least 10 grams of material.

6. If a more comprehensive characterization effort is desired additional sample locations may be added. These suggested locations are noted in italics. If the basic characterization is negative for the presence of beryllium, the more comprehensive sampling may not be warranted. However, collection of the additional samples on a separate occasion will result in additional cost.

7. Sample number does not include duplicates or field blanks. Duplicates are collected at a rate of 5% as appropriate for wipe and bulk samples. Field blanks are collected for air and wipe samples at a rate of 5% or one per sample set, which ever is greater.

8. Samples will be analyzed by an AIHA accredited lab using NIOSH method 7300. Analytes will include aluminum, arsenic, beryllium, cadmium, chromium, copper, iron, lead, magnesium, manganese, nickel, selenium, silver, uranium, and zinc.

9. The desired LOD and LOQ for wipe and air samples is $\leq 0.0168$ and $\leq 0.084$ *ug*/filter respectively. The desired LOQ for bulk samples is $\leq 0.6$ *ug*/g (ppm).

10. Wipe samples will be collected using Whatman filters. Air samples will be collected using MCE filters.

| **C-746A West Smelter** | |
|---|---|
| **Basis** | Some positive results from characterization of accessible surfaces but not warranting designation as a beryllium contamination area. Inaccessible surfaces may have greater concentrations of beryllium. |

# Sampling Strategy
# PGDP Site Assessment for Beryllium Contamination

| **Designation** | Possibly Contaminated | | | |
|---|---|---|---|---|
| **Location** | **Non-Random Wipe Samples** | **Personal Breathing Zone Samples** | **Area Air Samples** | **Bulk Samples** |
| General Area | - | 2 | 3 | - |
| High Surfaces | 29 | - | - | 6 |
| 2 Furnaces Interior | 12 (6 X 2) | - | - | 6 |
| **Total** | 41 + 3 duplicates + 3 blanks | 2 + 1 blank | 3 | 12 + 1 duplicate |

| **C-746A East Smelter** | | | | |
|---|---|---|---|---|
| **Basis** | Some positive results from characterization of accessible surfaces but not warranting designation as a beryllium contamination area. Inaccessible surfaces may have greater concentrations of beryllium | | | |
| **Designation** | Possibly Contaminated | | | |
| **Location** | **Non-Random Wipe Samples** | **Personal Breathing Zone Samples** | **Area Air Samples** | **Bulk Samples** |
| General Area | - | 2 | 3 | - |
| High Surfaces | 29 | - | - | 6 |
| Subsurface Pit | 6 | - | - | 6 |
| *Equipment (approximately 15 pieces)* | *90 (6 X 15)* | - | - | - |
| **Total** | 125 +7 duplicates + 7 blanks | 2 + 1 blank | 3 | 12 + 1 duplicate |

| **C-400 – East Side (Pulverizer side)** | | | | |
|---|---|---|---|---|
| **Basis** | Large amounts of metals were processed in the pulverizer. There is no known beryllium use. | | | |
| **Designation** | Assumed Clean | | | |
| **Location** | **Random Wipe Samples** | **Personal Breathing Zone Samples** | **Area Air Samples** | **Bulk Samples** |

| | | | | |
|---|---|---|---|---|
| General Area | - | 2 | 4 | - |
| High and Working Surfaces | 59 | - | - | 6 |
| **Total** | 59 + 3 duplicates + 3 blanks | 2 + 1 blank | 4 | 6 + 1 duplicate |

| **C-400 – Gold Room (DMSA 400-04)** | | | | |
|---|---|---|---|---|
| **Basis** | Crucibles associated with Work for Others program used for metals from C-746A smelters were stored in this room. | | | |
| **Designation** | Possibly contaminated | | | |
| **Location** | **Non-Random Wipe Samples** | **Personal Breathing Zone Samples** | **Area Air Samples** | **Bulk Samples** |
| General Area | - | See C-400 West Side | 1 | - |
| Room Surfaces | 10 (Room size, 15' x 15', does not warrant collection of 29 samples) | - | - | 3 |
| **Total** | 10 + 1 duplicate + 1 blank | - | 1 | 3 + 1 duplicate |

| **C-400 – West Side (Laundry side)** | | | | |
|---|---|---|---|---|
| **Basis** | Metals from C-746A smelters were processed in the gold dissolver as part of WFO program. | | | |
| **Designation** | Possibly contaminated | | | |
| **Location** | **Non-Random Wipe Samples** | **Personal Breathing Zone Samples** | **Area Air Samples** | **Bulk Samples** |
| General Area | - | 2 | 4 | - |
| High and Working Surfaces | 29 | - | - | 6 |
| *Exhaust Ventilation System* | *10* | - | - | |
| **Total** | 39 + 2 duplicates + 2 blanks | 2 + 1 blank | 4 | 6 + 1 duplicate |

# Sampling Strategy
# PGDP Site Assessment for Beryllium Contamination

| C-720 – Machine Shop | | | | |
|---|---|---|---|---|
| **Basis** | CuBe alloy was machined during WFO program. | | | |
| **Designation** | Possibly contaminated | | | |
| **Location** | **Non-Random Wipe Samples** | **Personal Breathing Zone Samples** | **Area Air Samples** | **Bulk Samples** |
| General Area | - | 3 | 4 | - |
| High and Working Surfaces | 29 | - | - | 6 |
| Individual Machines (Lathes, Drill Presses, Mills, Press) | 45 (3 X 15) | - | - | 6 |
| *Exhaust Ventilation System* | *10* | - | - | - |
| **Total** | 84 + 5 duplicates + 5 blanks | 3 + 1 blank | 4 | 12 + 1 duplicate |

| C-720 – Gauge Shop (possibly combine with machine shop if determined to be a homogeneous sample area) | | | | |
|---|---|---|---|---|
| **Basis** | CuBe alloy may have been machined during WFO program. | | | |
| **Designation** | Assumed Clean | | | |
| **Location** | **Non-Random Wipe Samples** | **Personal Breathing Zone Samples** | **Area Air Samples** | **Bulk Samples** |
| General Area | - | 1 | 1 | - |
| High and Working Surfaces | 29 | - | - | 3 |
| Lathe 33 | 6 | - | - | - |
| *Exhaust Ventilation System* | *6* | - | - | - |
| **Total** | 41 + 3 duplicates + 3 blanks | 1 + 1 blank | 1 | 3 + 1 duplicate |

# Sampling Strategy
# PGDP Site Assessment for Beryllium Contamination

| C-720 – Converter Shop | | | | |
|---|---|---|---|---|
| **Basis** | CuBe alloy was machined during WFO program. | | | |
| **Designation** | Possibly contaminated | | | |
| **Location** | **Non-Random Wipe Samples** | **Personal Breathing Zone Samples** | **Area Air Samples** | **Bulk Samples** |
| General Area | - | 2 | 3 | - |
| High and Working Surfaces | 29 | - | - | 3 (including insulating material on walls) |
| *Exhaust Ventilation System* | *6* | - | - | - |
| **Total** | 35 + 2 duplicates + 2 blanks | 2 + 1 blank | 3 | 3 + 1 duplicate |

| C-720 – Mezzanine Offices | | | | |
|---|---|---|---|---|
| **Basis** | Office make-up air may be drawn from the high bay area including the machine shop where CuBe was machined during WFO program. | | | |
| **Designation** | Assumed Clean | | | |
| **Location** | **Random Wipe Samples** | **Personal Breathing Zone Samples** | **Area Air Samples** | **Bulk Samples** |
| *Working Surfaces* | *59* | *1* | *4* | - |
| ***Total*** | *59 + 3 duplicates + 3 blanks* | *1 + 1 blank* | *4* | - |

| C-710 B-11 Machine Shop | | | | |
|---|---|---|---|---|
| **Basis** | CuBe alloy was machined during WFO program. | | | |
| **Designation** | Possibly contaminated | | | |
| **Location** | **Non-Random Wipe Samples** | **Personal Breathing Zone Samples** | **Area Air Samples** | **Bulk Samples** |
| General Area | - | 1 | 1 | - |
| High and Working Surfaces | 29 (Room size, 30' x 30', may permit fewer samples | - | - | - |

| | | | | |
|---|---|---|---|---|
| Individual Machines (Lathes, Drill Presses, Mills, Press) | 12 (6 X 2) | - | - | 3 |
| *Ventilation system* | *3* | - | - | - |
| **Total** | 44<br>+ 3 duplicates<br>+ 3 blanks | 1 + 1 blank | 1 | 3 + 1 duplicate |

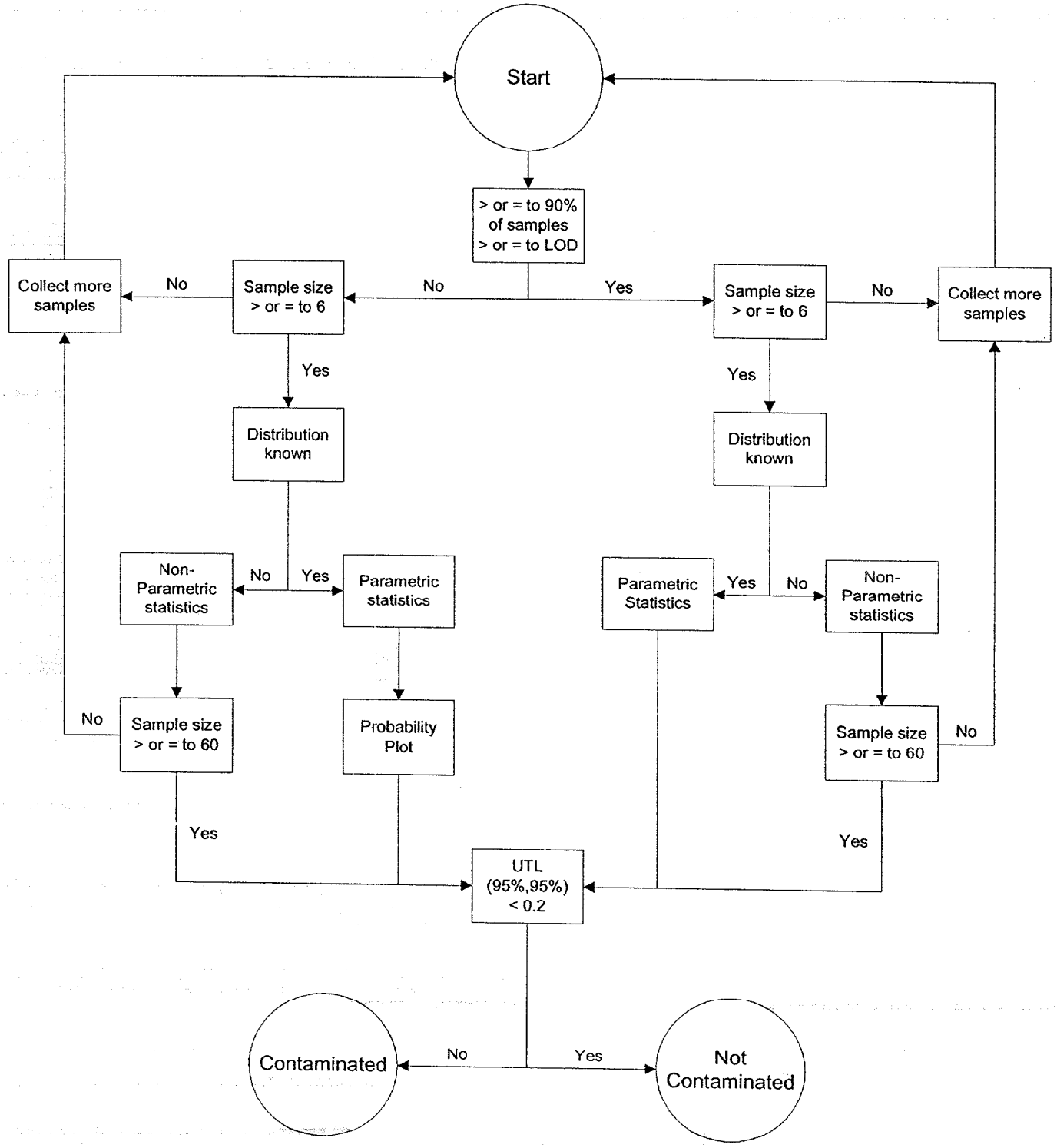
| **C-710 B-22 and B-13** | | | | |
|---|---|---|---|---|
| **Basis** | CuBe alloy may have been tested on the tensile test tables during WFO program. | | | |
| **Designation** | Assumed Clean | | | |
| **Location** | **Wipe Samples** | **Personal Breathing Zone Samples** | **Area Air Samples** | **Bulk Samples** |
| Tensile Test Tables (2) | 6 (3 X 2) | See C-710 B-11 | - | 3 |
| **Total** | 6<br>+ 1 duplicate<br>+ 1 blank | - | - | 3 + 1 duplicate |

| **PrSM Offices** | | | | |
|---|---|---|---|---|
| **Basis** | Demonstrate the beryllium levels in a "clean" area. | | | |
| **Designation** | Assumed Clean | | | |
| **Location** | **Wipe Samples** | **Personal Breathing Zone Samples** | **Area Air Samples** | **Bulk Samples** |
| Office Surfaces | 8 | - | - | - |
| **Total** | 8<br>+ 1 duplicate<br>+ 1 blank | - | - | |

# APPENDIX B

# Decision Logic for Analysis of Beryllium Data

# Decision Logic for Analysis of Beryllium Data




Based on statistical strategies defined in *A Strategy for Assessing and Managing Occupational Exposures*, 2nd Ed., American Industrial Hygiene Association, 1998

**C-710 B11**

1. < 90% of samples greater than LOD
2. Unknown distribution
3. Non-parametric statistics
4. Conclusion from pg. 284 (Table VIII.2)

**C-720 Mezzanine**

1. < 90% of samples greater than LOD
2. Unknown distribution
3. Non-parametric statistics
4. Conclusion from pg. 283 (Table VIII.1)

**C-400 East Side**

1. < 90% of samples greater than LOD
2. Unknown distribution
3. Non-parametric statistics
4. Conclusion from pg. 283 (Table VIII.1)

**C-400 West Side**

1. 90% of samples are greater than LOD
2. Log-normal distribution
3. Parametric statistics
4. Conclusion from AIHA spreadsheet

**C-720 Machine Shop (combined data)**

1. < 90% of samples greater than LOD
2. Log-normal distribution
3. Parametric statistics
4. Conclusion based on probability plot

**C-746A East Smelter Mezzanine**

1. < 90% of samples greater than LOD
2. Log-normal distribution
3. Parametric statistics
4. Conclusion based on probability plot

**C-746A Equipment and Northwest Corner**

1. > 90% of samples are greater than LOD
2. Log-normal distribution
3. Parametric statistics
4. Conclusion based on maximum likelihood estimate (MLE) pg. 257 – could also use standard UTL calculations instead

# APPENDIX C

## Sampling and Analytical Methods

# ELEMENTS by ICP 7300

MW: Table 1 CAS: Table 2 RTECS: Table 2

**METHOD: 7300, Issue 2** **EVALUATION: PARTIAL** **Issue 1: 15 August 1990**
**Issue 2: 15 August 1994**

**OSHA:** Table 2
**NIOSH:** Table 2
**ACGIH:** Table 2

**PROPERTIES:** Table 1

**ELEMENTS:**

| | | | | | |
|---|---|---|---|---|---|
| aluminum* | chromium* | lithium* | phosphorus | tellurium | zinc |
| aresenic | cobalt* | magnesium | platinum* | thallium | zirconium* |
| beryllium* | copper | manganese* | selenium | titanium | |
| Cadmium | iron | molybdenum* | silver | vanadium | |
| calcium | lead* nickel | sodium | yittrium | | |

*Some compounds of these elements require special sample treatment.

## SAMPLING

**SAMPLER:** FILTER (0.8-µm, cellulose ester membrane)

**FLOWRATE:** 1 to 4 L/min

**VOL-MIN:** Table 1
**-MAX:** Table 1

**SHIPMENT:** routine

**SAMPLE STABILITY:** stable

**BLANKS:** 2 to 10 field blanks per set

## ACCURACY

**RANGE STUDIED:** not studied

**BIAS:** none identified

**OVERALL PRECISION ($\hat{S}$):** not evaluated

**ACCURACY:** not determined

## MEASUREMENT

**TECHNIQUE:** INDUCTIVELY COUPLED ARGON PLASMA, ATOMIC EMISSION SPECTROSCOPY

**ANALYTE:** elements above

**ASHING REAGENTS:** conc. $HNO_3$, 4 mL; and conc. $HClO_4$, 1 mL

**CONDITIONS:** room temperature, 30 min; 150 °C to near dryness

**FINAL SOLUTION:** 4% $HNO_3$, 1% $HClO_4$, 10 mL

**WAVELENGTH:** depends upon element; Table 3

**BACKGROUND CORRECTION:** spectral wavelength shift

**CALIBRATION:** elements in 4% $HNO_3$, 1% $HClO_4$

**RANGE:** 2.5 to 1000 µg per sample [1]

**ESTIMATED LOD:** 1 µg per sample [1]

**PRECISION ($\hat{S}$):** Table 3

**APPLICABILITY:** The working range of this method is 0.005 to 2.0 mg/m$^3$ for each element in a 500-L air sample. This is simultaneous elemental analysis, not compound specific. An alternative microwave digestion procedure is included. Verify that the types of compounds in the samples are soluble with the ashing procedure selected.

**INTERFERENCES:** Spectral interferences are the primary interferences encountered in ICP-AES analysis. These are minimized by judicious wavelength selection, interelement correction factors and background correction [1,2].

**OTHER METHODS:** This method replaces P&CAM 351 [2] for trace elements. Flame atomic absorption spectroscopy (e.g., Methods 70XX) is an alternate analytical technique for many of these elements. Graphite furnace AAS (e.g., 7102 for Be, 7105 for Pb) is more sensitive.

**REAGENTS:**

1. Nitric acid, conc., ultra pure.
2. Perchloric acid, conc., ultra pure.*
3. Ashing acid: 4:1 (v/v) HNO3:HClO4. Mix 4 volumes conc. HNO3 with 1 volume conc. HClO4.
4. Calibration stock solutions, 1000 µg/mL. Commercially available, or prepared per instrument manufacturer's recommendation (see step 12).
5. Dilution acid, 4% HNO3, 1% HClO4. Add 50 mL ashing acid to 600 mL water; dilute to 1 L.
6. Argon.
7. Distilled,deionized water.

* See SPECIAL PRECAUTIONS.

**EQUIPMENT:**

1. Sampler: cellulose ester membrane filter, 0.8-µm pore size, 37-mm diameter; in cassette filter holder.
2. Personal sampling pump, 1 to 4 L/min, with flexible connecting tubing.
3. Inductively coupled plasma-atomic emission spectrometer, equipped as specified by the manufacturer for analysis of elements of interest.
4. Regulator, two-stage, for argon.
5. Beakers, Phillips, 125-mL, or Griffin, 50-mL, with watchglass covers.**
6. Volumetric flasks, 10- and 100- mL.**
7. Assorted volumetric pipets as needed.**
8. Hotplate, surface temperature 150°C.

** Clean all glassware with conc. nitric acid and rinse thoroughly in distilled water before use.

**SPECIAL PRECAUTIONS:** Perform all perchloric acid digestions in a perchloric acid hood.

**SAMPLING:**

1. Calibrate each personal sampling pump with a representative sampler in line.
2. Sample at an accurately known flow rate between 1 and 4 L/min for a total sample size of 200 to 2000 L (see Table 1) for TWA measurements. Do not exceed a filter loading of approximately 2 mg total dust.

**SAMPLE PREPARATION:**

3. Open the cassette filter holders and transfer the samples and blanks to clean beakers.
4. Add 5 mL ashing acid. Cover with a watchglass. Let stand 30 min at room temperature.
   NOTE: Start a reagent blank at this step.
5. Heat on hotplate (120°C) until ca. 0.5 mL remains.
   NOTE 1: Recovery of lead from some paint matrices may require other digestion techniques. See Method 7082 (Lead by Flame AAS) for an alternative hotplate digestion procedure or the Appendix for a microwave digestion procedure [8].
   NOTE 2: Some species of Al, Be, Co, Cr, Li, Mn, Mo, V, and Zr will not be completely solubilized by this procedure. Alternative solubilization techniques for most of these elements can be found elsewhere [2-7]. For example, aqua regia may be needed for Mn [4,9].
6. Add 2 mL ashing acid and repeat step 5. Repeat this step until the solution is clear.
7. Remove watchglass and rinse into the beaker with distilled water.
8. Increase the temperature to 150°C and take the sample to near dryness (ca. 0.5 mL).
9. Dissolve the residue in 2 to 3 mL dilution acid.
10. Transfer the solutions quantitatively to 10-mL volumetric flasks.
11. Dilute to volume with dilution acid.

**CALIBRATION AND QUALITY CONTROL:**

12. Calibrate the spectrometer according to the manufacturers recommendations.
    NOTE: Typically, an acid blank and 10 µg/mL multielement working standards are used. The following multielement combinations are chemically compatible in 4% HNO3/1%

HClO4:

a. Ag, Ca, Co, Mn, Pb, V, Zn;
b. Al, Be, Cd, La, Li, Ni, Tl;
c. As, B, Ba, Mg, Mo, P;
d. Cu, Fe, Na, Pt, Sr, Te, Y;
e. Cr, K, Se, Ti, Zr; and
f. Si, W (distilled water only)

13. Analyze a standard for every ten samples.
14. Check recoveries with at least two spiked media blanks per ten samples.

**MEASUREMENT:**

15. Set spectrometer to conditions specified by manufacturer.
16. Analyze standards and samples.

NOTE: If the values for the samples are above the range of the standards, dilute the solutions with dilution acid, reanalyze and apply the appropriate dilution factor in the calculations.

**CALCULATIONS:**

17. Obtain the solution concentrations for the sample, Cs (g/mL), and the average media blank, Cb (µg/mL), from the instrument.
18. Using the solution volumes of sample, Vs (mL), and media blank, Vb (mL), calculate the concentration, C (mg/m3), of each element in the air volume sampled, V (L):

$$C = \frac{C_s V_s - C_b V_b}{V}, \text{ mg/m}^3.$$

**EVALUATION OF METHOD:**

Method P&CAM 351 was evaluated in 1981 [1,2]. The precision and recovery data were determined at 2.5 and 1000 µg of each element per sample on spiked filters. The precision and recovery data, instrumental detection limits, sensitivity, and analytical wavelengths are listed in Table 3. The values in Table 3 were determined with a Jarrell-Ash Model 1160 ICP operated according to manufacturer's instructions.

**REFERENCES:**

[1] Hull, R.D. "Multielement Analysis of Industrial Hygiene Samples," NIOSH Internal Report, presented at the American Industrial Hygiene Conference, Portland, Oregon (May 1981).
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[3] Ibid, S341 (Lead).
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**METHOD WRITTEN BY:**

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James B. Perkins, David L. Wheeler, and Keith Nicholson, DataChem Labortories, Salt Lake City, UT, prepared the microwave digestion procedure in the Appendix.

**TABLE 1. PROPERTIES AND SAMPLING VOLUMES**

| Element (Symbol) | Properties: Atomic Weight | Properties: MP,°C | Air Volume, L @ OSHA PEL: MIN | Air Volume, L @ OSHA PEL: MAX |
|---|---|---|---|---|
| Silver (Ag) | 107.87 | 961 | 250 | 2000 |
| Aluminum (Al) | 26.98 | 660 | 5 | 100 |
| Arsenic (As) | 74.92 | 817 | 5 | 2000 |
| Beryllium (Be) | 9.01 | 1278 | 1250 | 2000 |
| Calcium (Ca) | 40.08 | 842 | 5 | 200 |
| Cadmium (Cd) | 112.40 | 321 | 13 | 2000 |
| Cobalt (Co) | 58.93 | 1495 | 25 | 2000 |
| Chromium (Cr) | 52.00 | 1890 | 5 | 1000 |
| Copper (Cu) | 63.54 | 1083 | 5 | 1000 |
| Iron (Fe) | 55.85 | 1535 | 5 | 100 |
| Lithium (Li) | 6.94 | 179 | 100 | 2000 |
| Magnesium (Mg) | 24.31 | 651 | 5 | 67 |
| Manganese (Mn) | 54.94 | 1244 | 5 | 200 |
| Molybdenum (Mo) | 95.94 | 651 | 5 | 67 |
| Sodium (Na) | 22.99 | 98 | 13 | 2000 |
| Nickel (Ni) | 58.71 | 1453 | 5 | 1000 |
| Phosphorus (P) | 30.97 | 44 | 25 | 2000 |
| Lead (Pb) | 207.19 | 328 | 50 | 2000 |
| Platinum (Pt) | 195.09 | 1769 | 1250 | 2000 |
| Selenium (Se) | 78.96 | 217 | 13 | 2000 |
| Tellurium (Te) | 127.60 | 450 | 25 | 2000 |
| Titanium (Ti) | 47.90 | 1675 | 5 | 100 |
| Thallium (Tl) | 204.37 | 304 | 25 | 2000 |
| Vanadium (V) | 50.94 | 1890 | 5 | 2000 |
| Yttrium (Y) | 88.91 | 1495 | 5 | 1000 |
| Zinc (Zn) | 65.37 | 419 | 5 | 200 |
| Zirconium (Zr) | 91.22 | 1852 | 5 | 200 |

## TABLE 2. EXPOSURE LIMITS, CAS #, RTECS

| Element (Symbol) | CAS # | RTECS | Exposure Limits, mg/m³ (Ca = carcinogen) OSHA | NIOSH | ACGIH |
|---|---|---|---|---|---|
| Silver (Ag) | 7440-22-4 | VW3500000 | 0.01 (dust, fume, metal) | 0.01 (metal, soluble) | 0.1 (metal)<br>0.01 (soluble) |
| Aluminum (Al) | 7429-90-5 | BD0330000 | 15 (total)<br>5 (respirable) | 5 | 10 (dust)<br>5 (fume) |
| Arsenic (As) | 7440-38-2 | CG0525000 | varies | C 0.002, Ca | 0.01, Ca |
| Beryllium (Be) | 7440-41-7 | DS1750000 | 0.002, C 0.005 | 0.0005, Ca | 0.002, Ca |
| Calcium (Ca) | -- | -- | varies | varies | varies |
| Cadmium (Cd) | 7440-43-9 | EU9800000 | 0.2, C 0.6 (dust)<br>0.1, C 0.3 (fume) | lowest feasible, Ca | 0.01 (total), Ca<br>0.002 (respir.), Ca |
| Cobalt (Co) | 7440-48-4 | GF8750000 | 0.1 | 0.05 | 0.05 (dust, fume) |
| Chromium (II) (Cr) | 22541-79-3 | GB6260000 | 0.5 | 0.5 | 0.5 |
| Chromium (III) (Cr) | 16065-83-1 | GB6261000 | 0.5 | 0.5 | 0.5 |
| Chromium (VI) (Cr) | 18540-29-9 | GB6262000 | C 0.1 | 0.001 (dust) | 0.05 (soluble)<br>0.05 (insoluble), Ca |
| Copper (Cu) | 7440-50-8 | GL5325000 | 1 (dust, mists)<br>0.1 (fume) | 1 (dust)<br>0.1 (fume) | 1 (dust, mists)<br>0.2 (fume) |
| Iron (Fe) | 1309-37-1 | NO7400000 | 10 (dust, fume) | 5 (dust, fume) | 5 (fume) |
| Lithium (Li) | -- | -- | -- | -- | -- |
| Magnesium (Mg) | 1309-48-4 | OM3850000 | 15 (dust) as oxide<br>5 (respirable) | 10 (fume) as oxide | 10 (fume) as oxide |
| Manganese (Mn) | 7439-96-5 | OO9275000 | C 5 | 1; STEL 3 | 5 (dust)<br>1; STEL 3 (fume) |
| Molybdenum (Mo) | 7439-98-7 | QA4680000 | 5 (soluble)<br>15 (total insoluble)<br>5 (respirable insol.) | 5 (soluble)<br>10 (insoluble) | 5 (soluble)<br>10 (insoluble) |
| Nickel (Ni) | 7440-02-0 | QR5950000 | 1 | 0.015, Ca | 0.05, Ca |
| Lead (Pb) | 7439-92-1 | OF7525000 | 0.05 | <0.1 | 0.05 |
| Platinum (Pt) | 7440-06-4 | TP2160000 | 0.002 | 1 (metal) | 1 (metal) |
| Selenium (Se) | 7782-49-2 | VS7700000 | 0.2 | 0.2 | 0.2 |
| Tellurium (Te) | 13494-80-9 | WY2625000 | 0.1 | 0.1 | 0.1 |
| Titanium (Ti)<br>$TiO_2$ | 7440-32-6<br>13463-67-7 | XR1700000<br>XR2275000 | as $TiO_2$, 15<br>as $TiO_2$, 5 (respirable) | lowest feasible, Ca | 10 |
| Thallium (Tl) | 7440-28-0 | XG3425000 | 0.1 (skin) (soluble) | 0.1 (skin) (soluble) | 0.1 (skin) |
| Vanadium (V)<br>$V_2O_5$ | 7440-62-2<br>1314-62-1 | YW240000<br>YW1355000 | C 0.5 (respirable) as $V_2O_5$<br>C 0.1 (fume) as $V_2O_5$ | C 0.05 | 0.05 (respir.) as $V_2O_5$ |
| Yttrium (Y) | 7440-65-5 | ZG2980000 | 1 | 1 | 1 |
| Zinc (Zn) | 1314-13-2 | ZH4810000 | 5 (ZnO fume)<br>15 (ZnO dust)<br>5 (ZnO respirable) | 5; STEL 10 (ZnO fume)<br>5; C 15 (ZnO dust) | 5; STEL 10 (ZnO fume)<br>10 (ZnO dust) |
| Zirconium (Zr) | 7440-67-7 | ZH7070000 | 5 | 5, STEL 10 | 5, STEL 10 |

**TABLE 3. MEASUREMENT PROCEDURES AND DATA[a]**

| Element | Wavelength (nm) | Instrumental LOD (ng/mL) | Sensitivity (Intensity/ µg/mL) | Recovery @ 2.5 µg/ filter [b] | Recovery @ 1000 µg/ filter | Precision ($\hat{S}_r$) (N = 3) @ 2.5 µg/ filter | Precision ($\hat{S}_r$) (N = 3) @ 1000 µg/ filter |
|---|---|---|---|---|---|---|---|
| Ag | 328.3 | 26 | 0.65 | 111 | 91 | 0.02 | 0.075 |
| Al | 308.2 | 14 | 0.23 | 93 | 100 | 0.092 | 0.023 |
| As | 193.7 | 13 | 0.57 | 103 | 99 | 0.062 | 0.026 |
| Be | 313.0 | 1.5 | 1.29 | 107 | 90 | 0.040 | 0.034 |
| Ca | 315.9 | 10 | 0.49 | 99 | 95 | 0.036 | 0.014 |
| Cd | 226.5 | 1.6 | 0.83 | 107 | 99 | 0.032 | 0.020 |
| Co | 231.2 | 7.4 | 0.38 | 101 | 95 | 0.040 | 0.005 |
| Cr | 205.6 | 1.3 | 0.50 | 98 | 106 | 0.053 | 0.016 |
| Cu | 324.8 | 2.1 | 0.72 | 98 | 99 | 0.036 | 0.022 |
| Fe | 259.9 | 3.9 | 0.13 | 94 | 97 | 0.068 | 0.016 |
| Li | 670.8 | 2.8 | 0.48 | 89 | 95 | 0.171 | 0.043 |
| Mg | 279.6 | 24 | 0.22 | 105 | 106 | 0.084 | 0.027 |
| Mn | 257.6 | 0.4 | 0.74 | 84 | 93 | 0.062 | 0.035 |
| Mo | 281.6 | 7.0 | 0.18 | 94 | 88 | 0.023 | 0.049 |
| Na | 589.0 | 10 | 0.76 | (c) | 101 | (c) | 0.045 |
| Ni | 231.6 | 3.4 | 0.41 | 105 | 97 | 0.027 | 0.020 |
| P | 214.9 | 22 | 0.17 | (c) | 91 | (c) | 0.056 |
| Pb | 220.4 | 17 | 0.42 | 105 | 95 | 0.060 | 0.011 |
| Pt | 203.7 | 15 | 0.69 | 106 | 91 | 0.041 | 0.075 |
| Se | 190.6 | 21 | 0.28 | 105 | 97 | 0.068 | 0.049 |
| Sn[d] | 190.0 | 64 | 0.49 | 74 | 67 | 0.33 | 0.16 |
| Te | 214.3 | 29 | 0.41 | 102 | 94 | 0.050 | 0.063 |
| Ti | 334.9 | 1.2 | 0.55 | 96 | 108 | 0.051 | 0.029 |
| Tl | 190.9 | 17 | 0.22 | 103 | 99 | 0.043 | 0.017 |
| V | 310.2 | 3.2 | 0.88 | 99 | 94 | 0.043 | 0.014 |
| W[d] | 207.9 | 13 | 2.58 | 35 | 23 | 0.053 | 0.60 |
| Y | 371.0 | 0.8 | 2.35 | 99 | 100 | 0.015 | 0.013 |
| Zn | 213.9 | 0.6 | 0.60 | 101 | 94 | 0.013 | 0.013 |
| Zr | 339.2 | 1.9 | 0.88 | 75 | 98 | 0.049 | 0.008 |

(a) Values reported were obtained with a Jarrell-Ash Model 1160 ICP; performance may vary with instrument and should be independently verified.
(b) 2.5 µg/filter corresponds to 5 µg/m$^3$ for a 500-L air sample.
(c) Blank levels too high to make accurate determinations.
(d) Qualitative only because of low recovery.

## APPENDIX - MICROWAVE DIGESTION FOR LEAD IN PAINT CHIPS (AND OTHER MATRICES)

This procedure is an alternative to the procedure presented in the Sample Preparation section of this method. It provides a rapid, complete acid digestion prior to analysis by flame atomic absorption (FAA), heated graphite furnace atomic absorption (HGFAA), and inductively coupled plasma spectroscopy (ICP) [10].

Apparatus and Material[11-16]

1. Microwave apparatus requirements:
   a. The microwave unit provides programmable power with a minimum of 574 W and can be programmed to within ± 10 W of the required power.
   b. The microwave unit cavity is corrosion resistant as well as ventilated. All electronics are protected against corrosion for safe operation.
   c. The system requires Teflon PFA digestion vessels (120-mL capacity) capable of withstanding pressures up to 7.5 ± 0.7 atm (110 ± 10 psi) and capable of controlled pressure relief at pressures exceeding 7.5 ± 0.7 atm (110 ± 10 psi).
   d. A rotating turntable is employed to ensure homogeneous distribution of microwave radiation within the unit. The speed of the turntable should be a minimum of 3 rpm.
   e. A safety concern relates to the use of sealed containers without pressure relief valves in the unit. Temperature is the important variable controlling the reaction. Pressure is needed to attain elevated temperatures but must be safely contained [12].
   f. Polymeric volumetric ware in plastic (Teflon or polyethylene), 50- or 100-mL capacity.
   g. Disposable polypropylene filter funnel.
   h. Analytical balance, 300-g capacity, and minimum ± 0.001 g.

Reagents

1. Nitric acid, concentrated, spectroscopy grade.
2. Reagent Water. Reagent water shall be interference free. All references to water in the method refer to reagent water that meets the ASTM Type 2 standard.

Procedure

1. Calibration of Microwave Equipment.
   Calibrate microwave equipment in accordance with manufacturer's instructions. If calibration instructions are not available, see EPA Method 3051 [11].
2. All digestion vessels and volumetric ware must be carefully acid washed and rinsed with reagent water. All digestion vessels should be cleaned by leaching with hot (1:1) nitric acid for a minimum of fifteen minutes, rinsed with reagent water, and dried in a clean environment.
3. Sample Digestion
   a. Tare the Teflon PFA digestion vessel.
   b. Weigh out 0.1 g paint chip sample to the nearest 0.001 g into the tared Teflon PFA sample vessel. With large paint chip samples, measure out a 2 $cm^2$ piece, weigh to the nearest 0.001 g, and quantitatively transfer it to the vessel.
   c. Add 5.0 ± 0.1 mL concentrated nitric acid to the sample vessel in a fume hood. If a vigorous reaction occurs, allow the reaction to stop before capping the vessel. Cap the vessel and torque the cap to 12 ft-lb (16 N-m) according to the manufacturer's directions. The sample vessel may be connected to an overflow vessel using Teflon PFA connecting tubes. Place the vessels in the microwave carrousel. Connect the overflow vessels to the center well of the unit.
   d. Place the vessels evenly distributed in the turntable of the microwave unit using groups of two, six, or 12 sample vessels. Any vessels containing 5 mL of nitric acid for reagent blank purposes are counted as sample vessels. When fewer than the recommended number of samples are to be digested, i.e., three samples plus one blank, the remaining vessels should be filled with 5 mL of nitric acid to achieve the full complement of vessels. This provides an energy balance since the microwave power absorbed is proportional to the total mass in the cavity [14]. Irradiate each group of samples to achieve a temperature of 180°C in five minutes at a pressure of 50 psi. Continue to irradiate to achieve a temperature of 180°C at 100 psi after 25 minutes. Continue

digestion for five minutes. A sample digestion program for 12 samples is presented in the following table.

**PROGRAM VARIABLES FOR PAINT CHIPS SAMPLE DIGESTION WITH NITRIC ACID**

| Stage | (1) | (2) | (3) |
|---|---|---|---|
| Power | 90% | 90% | 0% |
| Pressure, psi | 50 | 100 | 0 |
| Run Time, min | 10:00 | 20:00 | 05:00 |
| Time @ P, min | 05:00 | 15:00 | 00:00 |
| Temperature | 180°C | 180°C | 0°C |
| Fan Speed | 100% | 100% | 100% |
| Number of Vessels: | 12 | | |
| Liquid Volume per Vessel: | 5 mL | | |
| Sample Weight: | 0.1 g | | |

If the analyst wishes to digest other than two, six, or 12 samples at a time, use different values of power as long as they result in the same time and temperature conditions.

e. At the end of the microwave program, allow the vessels to cool for a minimum of five minutes before removing them from the microwave unit. If a loss of sample is detected (e.g., material in overflow collection vessel, liquid outside liner), determine the reason for the loss (e.g., loss of vessel seal integrity, use of a digestion time longer than 30 minutes, too large a sample, or improper heating conditions). Once the source of the loss has been corrected, prepare a new sample beginning at Section 2. If insufficient material is available for reanalysis, dilute remaining digestate and note that some sample loss may have occurred.

f. Uncap and vent each vessel in a fume hood. Add 20 mL reagent water, then reseal vessels and shake to mix thoroughly. Transfer the sample to an acid-cleaned polyethylene bottle. If the digested sample contains particulates which may clog nebulizers or interfere with injection of the sample into the instrument, allow the sample to settle or filter it:

**Settling:** Allow the sample to stand until the supernatant is clear (usually, overnight is sufficient). If it does not clear, filter the sample.

**Filtering:** The filtering apparatus must be thoroughly precleaned and rinsed with dilute nitric acid. Filter the sample through quantitative filter paper into a second acid-cleaned container.

The digestate is now ready for analysis for elements of interest using the appropriate method.

4. Calculations: Report the concentrations based on the actual weight of the original sample.

Implement as ammended- EMA 4/22/03

## 1.0 PURPOSE

The purpose of this procedure is to describe proper methods for collecting bulk samples of dust for analysis.

## 2.0 SCOPE

This procedure is applicable to PrSM Corporation and subcontractors conducting field-sampling activities.

## 3.0 DEFINITIONS

See attachment.

## 4.0 RESPONSIBILITIES

1. Project Manager
   a. Includes the requirements of this procedure, as applicable, in the project Sampling and Analysis Plan (SAP).
   b. Directs the field team leader in implementation of the requirements found in this procedure.
   c. Ensures, that applicable training and safety requirements are verified and documented as required for this procedure.
   d. Verifies, using surveillance and audits, that the requirements of this procedure are properly satisfied.
   e. Authorizes deviations from this procedure.

2. Field Team Leader
   a. Directs the activities of the field team for the correct application of this procedure.
   b. Verifies that practices and documentation meet the requirements of this procedure.
   c. Records deviations from the requirements of this procedure.

3. Field Team Members
   a. Shall be trained and knowledgeable of the requirements of this procedure prior to start of field activities.
   b. Adhere to the requirements of this procedure.
   c. Eliminate unauthorized deviations while performing this procedure.

## 5.0 PRECAUTIONS AND LIMITATIONS

This procedure applies to bulk dust sampling for analysis to identify metals. Sampling for other types of contaminants (e.g., asbestos, microorganisms, organics) may require modifications to the procedure.

**6.0 PROCEDURE**

~~See attachment.~~ EMA 4/22/03

**7.0 REQUIRED RECORDS**

1. Completed Bulk Dust Sampling Data Sheets.
2. Completed Sample Chain of Custody Records.

**8.0 REFERENCES**

1. American Society for Testing and Materials, E1727-99 Standard Practice Field Collection of Soil Samples for Lead Determination by Atomic Spectrometry Techniques.
2. Quality System Procedure 7.1 Project Planning Process.

**9.0 ATTACHMENTS (Forms)**

1. Bulk Dust Sampling Data Sheet

**10.0 KEY WORDS**

sampling, bulk, dust, metals

**11.0 APPROVALS**

| Approved: CG-Signature on File | Approved: GAW-Signature on File |
|---|---|
| Management Representative / Date | Chief Executive Officer / Date |

6.C Procedure

Identify appropriate material for sample collection. Using a sampling aid such as a folded piece of paper or a gloved hand, scoop material into a sample container. Close the container & decontaminate the outside as necessary. EMA 4/22/03

## BULK DUST SAMPLING DATA SHEET

Location Sketch

Project No.: BEC0100.04-03-01

Sample No.: _____

Sample Date: _____

Sample Time: _____

Collected by: Rodgers / Allison

COC No.: _____

Building No.: _____

Room No.: _____

Elevation: _____

**Sample Collected From::**

_____ floor _____ process equipment _____ furniture

_____ ceiling _____ ductwork _____ misc. horizontal surface

_____ other _____

Analysis Requested: NIOSH 7300 - Beryllium

Laboratory Results: _____

Related Duplicate Sample ?: _____ No ____ Yes, sample no. _____

**COMMENTS:**

_____

_____

_____

_____

TP-004, (REV 1)
January 31, 2003

Completed by: _____
Checked by: _____

Designation: E 1727 – 99

An American National Standard

# Standard Practice for Field Collection of Soil Samples for Lead Determination by Atomic Spectrometry Techniques[1]

This standard is issued under the fixed designation E 1727; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

## 1. Scope

1.1 This practice covers the collection of soil samples using coring and scooping methods. Soil samples are collected in a manner that will permit subsequent digestion and determination of lead using laboratory analysis techniques such as Inductively Coupled Plasma Atomic Emission Spectrometry (ICP-AES), Flame Atomic Absorption Spectrometry (FAAS), and Graphite Furnace Atomic Absorption Spectrometry (GFAAS).

1.2 This practice is not suitable for collection of soil samples from areas that are paved.

1.3 This practice does not address the sampling design criteria (that is, sampling plan that includes the number and location of samples) that are used for risk assessment and other purposes. To provide for valid conclusions, sufficient numbers of samples must be obtained as directed by a sampling plan.

1.4 This practice contains notes that are explanatory and are not part of the mandatory requirements of this practice.

1.5 The values stated in SI units are to be regarded as the standard. The inch-pound units given in parentheses are for information only.

1.6 *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.*

## 2. Terminology

2.1 *Definitions:*

2.1.1 *sampling location*—a specific area within a sampling site that is subjected to sample collection. Multiple sampling locations are commonly designated for a single sampling site.

2.1.2 *sampling site*—a local geographical area that contains the sampling locations. A sampling site is generally limited to an area that is easily covered by walking.

2.1.3 *soil collection container*—a container for holding and transporting the soil sample from the field to the laboratory. A sealable rigid walled container or a resealable plastic bag can be used. The internal volume must be sufficient to hold the entire collected sample.

## 3. Summary of Practice

3.1 Soil samples are collected using coring or scooping methods.

## 4. Significance and Use

4.1 This practice is intended for the collection of soil samples in and around buildings and related structures for the subsequent determination of lead concentration, such as described in the HUD Guidelines.[2] This practice may also be used to collect soil samples from other environments for lead analysis.

4.2 This practice limits soil collection to approximately the top 1.5 cm of soil surface.

## 5. Apparatus and Materials

5.1 *Soil Coring Tool*, minimum diameter of 2.5 cm, or as agreed upon by the parties requesting and collecting the samples, lead-free, for use in coring. The tool shall be capable of being forced into hard ground without damage to a depth of at least 5 cm (2 in.) and have a mechanism to remove the core from the tool to permit discarding all but the top 1.5 cm (0.6 in.) of the soil core (see Note 1).

NOTE 1—A number of devices can be used or modified for use as soil coring tools. For example: professional stainless steel coring tools equipped with plastic liners, steel pipe, plastic pipe, or small sapling (tree) planters. Removal of the soil core is generally performed using a pair of plungers cut to fit the inside diameter of the coring device. One plunger is equipped with a stop that limits extension of the plunger to within 1.5 cm from the far end of the coring tool. It is used to remove all except the top 1.5 cm of the soil core from the coring tool. The other plunger (without a stop) is used to remove the remaining 1.5 cm of the soil core from the coring tool. The coring procedure in this practice assumes the coring tool has been equipped with these two types of plungers.

5.2 *Plastic Centrifuge Tubes*, for use in scooping; 50 mL with tight fitting cap. These tubes are not prohibited from serving as soil collection containers.

5.3 *Spoon*, lead-free, for use in scooping.

5.4 *Plastic Bags*, for use as soil collection containers; approximately 1 L or 4 L (1 qt or 1 gal) resealable plastic bags.

5.5 *Steel or Plastic Measuring Tape.*

[1] This practice is under the jurisdiction of ASTM Committee E-6 on Performance of Buildings and is the direct responsibility of Subcommittee E06.23 on Lead Paint Abatement.

Current edition approved Dec. 10, 1999. Published March 2000. Originally published as ES 29 – 94. Last previous edition E 1727 – 95.

[2] *Guidelines for the Evaluation and Control of Lead-Based Paint Hazards in Housing*, U.S. Department of HUD, Washington, DC, June 1995.





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5.6 *Plastic Gloves*, powderless.

5.7 *Permanent Ink Marker*.

5.8 *Wipe*—Disposable towelettes moistened with a wetting agent. This towel is used to clean sampling equipment. Wipe brands or sources selected for use shall contain insignificant background lead levels. Rinsing with drinking water will also assist in cleaning sampling equipment.

## 6. Procedure for Core Sampling

6.1 The following procedure is for collection of soils using a coring method at a given sample location within a sampling site. Coring methods are effective for collection from dense, hard, or sticky soils. Coring methods are not intended for collection of loose, sandy soils (see Note 2).

NOTE 2—Coring methods are more effective than scooping methods for the collection of reproducible replicate samples. Coring methods have the advantage of sampling a reproducible cross-sectional area and depth.

6.1.1 Don a pair of clean, powderless, plastic gloves (see Note 3).

NOTE 3—Lead contamination problems during field sampling can be severe and can affect soil analysis results. Contamination can be minimized through adherence to the following recommendations: change gloves frequently. Collection of each new sample should be conducted with a new pair of gloves. Powderless gloves are recommended to minimize contamination of the collected soil from powders used in "powdered" gloves. Clean sampling equipment and measuring tapes frequently with wipes or water. Do not handle soil collection containers until just prior to use.

6.1.2 If needed, clean the coring tool using wipes or drinking water. Check the stop on the core plunger (the one with a stop) to ensure that the plunger tip stops at a distance of 1.5 cm from the end of the coring tool or the portion of the tool that collects the soil core. Adjust the stop if needed.

6.1.3 Place a directional arrow on the outside of the tool with the head pointed toward the ground (see Notes 4-6). Grip the coring tool firmly between two hands and drive the tool into the soil surface at the designated sampling location with the directional arrow point facing down using a slight twisting motion to a depth of approximately 5 cm (2 in.).

NOTE 4—The directional arrow is used to identify which end of soil core is the top (that is, the surface of the ground). Its use will avoid inadvertent loss of the top of the soil core when the plungers are used to remove and collect the soil sample.

NOTE 5—Use of a professional stainless steel coring tool equipped with plastic liners may require insertion of a plastic liner and assembly. Follow the manufacturers instruction for proper setup using these types of coring tools, prior to driving the tool into the ground. For coring tools that use liners, the directional arrow must be marked on the liner, not the tool.

NOTE 6—For extremely hard soils (that is, hard packed or frozen), a hammer or other similar device may be needed to drive the tool into the ground. If conditions do not allow for full penetration to 5 cm, make every effort to penetrate to a depth of at least 1.5 cm. If the penetration is less than 1.5 cm, documentation generated for the sample should indicate the approximate depth achieved.

6.1.4 Twist and snap the coring tool to one side and carefully remove the tool from the ground while retaining the soil core in the tool.

6.1.5 Insert a clean plunger (with stop) into the top end of the liner. (The bottom end is indicated by the arrow head drawn on the tool. The top end is the opposite opening.) Push out all but 1.5 cm of the soil core from the tool with the plunger. Using a gloved finger, wipe off the excess soil protruding from the tool. Discard the soil pushed out of the tool.

6.1.6 Using a clean plunger (without stop), push the remaining 1.5 cm section of the core sample into a soil collection container.

6.1.7 Collect two more soil cores within a 0.3 m (1 ft) diameter circle around the first core using the same procedure described in 6.1.2-6.1.6. Composite these cores into the same soil collection container. Label the soil collection container with sufficient information to uniquely identify the sample. Discard the gloves in the trash bag after all three cores have been collected and composited.

6.1.8 Don a pair of clean, powderless, plastic gloves. Clean the coring tool and plungers using wipes or drinking water until visibly clean after each use. Discard the wipes and gloves in a trash bag.

## 7. Procedure for Scoop Sampling

7.1 The following procedures are for collection of soils using scoop sampling methods. For scoop sampling, collect soils at a given sample location within a sampling site using one of the methods. Scooping methods are effective for collection from semisoft, sticky, and loose, sandy soils (see Note 2). Scooping methods are not intended for the collection of soils from very hard or frozen soils.

NOTE 7—The scooping methods described here may result in collection bias toward increased amounts of surface soil as opposed to subsurface soil because of the curvature of the collection tools.

7.1.1 *Scoop Sampling Using a Plastic Centrifuge Tube*:

7.1.1.1 Don a pair of clean, powderless, plastic gloves (see Note 3).

7.1.1.2 Determine the proper burying depth of the tube needed to collect approximately the top 1.5 cm of soil using a measuring tape and a plastic 50-mL centrifuge tube (see Note 8).

NOTE 8—For example; if the plastic centrifuge tube is about 3 cm in diameter, then the proper burying depth during scooping is to insert the tube into the soil until the soil surface is about even with the center of the tube.

7.1.1.3 Remove the cap of the plastic centrifuge tube and insert the open end of the tube into the soil at the sampling location to the desired depth as determined in 7.1.1.2. Collect the soil into the tube by pushing or pulling the tube through the soil surface while maintaining the burying depth of the tube in the soil. Move the tube a distance of 10 to 20 cm (4 to 8 in.) across the soil surface to complete collection of the soil into the tube.

7.1.1.4 Remove the tube from the ground and wipe off any excess soil clinging to the outside of the tube and cap threads with a gloved finger. Replace the cap. Label the plastic centrifuge tube with sufficient information to uniquely identify the sample. Discard the gloves in the trash bag.

7.2 *Scoop Sampling Using a Spoon*:

7.2.1 Don a pair of clean, powderless, plastic gloves (see Note 3).

7.2.2 Using a measuring tape and a clean spoon, dig a small test hole adjacent to the sampling location to the depth of 1.5

cm. Use this hole as a visual aid during soil collection to help limit collection to a depth of 1.5 cm. Clean the spoon using a wipe.

7.2.3 Collect soil into a soil collection container by scooping soil with the spoon down to the depth indicated by the test hole (see 7.2.2). Continue to collect soil until a circular hole of approximately 5 cm diameter (1.5 cm deep) has been created.

7.2.4 Collect soil from two more locations within a 0.3 m (1 ft) diameter circle around the first sample location using the same procedure described in 7.2.1-7.2.3. Composite these scoop samples into the same soil collection container. Label the soil collection container with sufficient information to uniquely identify the sample. Discard the gloves in a trash bag after all three scoop samples have been collected and composited.

7.2.5 Don a pair of clean, powderless, plastic gloves. Wipe off the spoon after each use. Discard the wipes and gloves in the trash bag.

## 8. Report

8.1 Field data related to sample collection shall be documented in a sample log form or field notebook (see Note 9). If field notebooks are used, then field notebooks shall be bound with prenumbered pages. All entries on sample data forms and field notebooks shall be made using ink with signature and date of entry. Any entry errors shall be corrected by using only a single line through the incorrect entry (no scratch outs) accompanied by the initials of the person making the correction and the date of correction (see Note 10).

NOTE 9—Field notebooks are useful for recording field data even when preprinted sample data forms are used.

NOTE 10—These procedures are important to properly document and trace field data.

8.2 At a minimum, document the following information:

8.2.1 Project or client name, address, and city/state location,

8.2.2 General sampling site description,

8.2.3 Information as to what specific collection protocol was used,

8.2.4 For each sample collected: an individual and unique sample identifier and date of collection. This shall be recorded on the sample container in addition to the field documentation, and

8.2.5 For each sample collected: name of person collecting the sample and specific sampling location data from which the sample was removed.

## 9. Keywords

9.1 coring; lead; sample collection; scooping; soil

Implement as modified. EMA 4/22/03

## 1.0 PURPOSE

The purpose of this procedure is to describe proper methods for collecting samples of settled dust from surfaces for subsequent analysis.

## 2.0 SCOPE

This procedure is applicable to PrSM Corporation and subcontractors conducting field-sampling activities.

## 3.0 DEFINITIONS

See attachment.

## 4.0 RESPONSIBILITIES

1. Project Manager
   a. Includes the requirements of this procedure, as applicable, in the project Sampling and Analysis Plan (SAP).
   b. Directs the field team leader in implementation of the requirements found in this procedure.
   c. Ensures, that applicable training and safety requirements are verified and documented as required for this procedure.
   d. Verifies, using surveillance and audits, that the requirements of this procedure are properly satisfied.
   e. Authorizes deviations from this procedure.

2. Field Team Leader
   a. Directs the activities of the field team for the correct application of this procedure.
   b. Verifies that practices and documentation meet the requirements of this procedure.
   c. Records deviations from the requirements of this procedure.

3. Field Team Members
   a. Shall be trained and knowledgeable of the requirements of this procedure prior to start of field activities.
   b. Adhere to the requirements of this procedure.
   c. Eliminate unauthorized deviations while performing this procedure.

## 5.0 PRECAUTIONS AND LIMITATIONS

This procedure applies to surface wipe sampling for surface dust for analysis to identify metals. Sampling for other types of contaminants may require modifications to the procedure.

## 6.0 PROCEDURE

See attachment.

## 7.0 REQUIRED RECORDS

1. Completed Surface Wipe Sampling Data Sheets.
2. Completed Sample Chain of Custody Records.

## 8.0 REFERENCES

Quality System Procedure 7.1 Project Planning Process

## 9.0 ATTACHMENTS (Forms)

1. Surface Wipe Sample Data Sheet
2. American Society for Testing and Materials, E1728-02, Standard Practice for Collection of Settled Dust Samples Using Wipe Sampling Methods for Subsequent Lead Determination

## 10.0 KEY WORDS

sampling, wipe, surface

## 11.0 APPROVALS

| | |
|---|---|
| Approved:<br>CG-Signature on File | Approved:<br>GAW-Signature on File |
| Management Representative / Date | Chief Executive Officer / Date |

PSM

# SURFACE WIPE SAMPLING DATA SHEET

Location Sketch

Project No.: _____

Sample No.: _____

Sample Date: _____

Sample Time: _____

Collected by: _____

COC No.: _____

Building No.: _____

Room No.: _____

Elevation: _____

**Sampling Area:**

_____ floor _____ process equipment _____ furniture

_____ ceiling tile _____ ductwork _____ misc. horizontal surface

_____ other _____

Analysis Requested: _____

Surface Area Wiped: _____ 100 $cm^2$ _____ 1 $ft^2$ ___ other _____

Laboratory Results: _____

Related Duplicate Sample?: _____ No ____ Yes, sample no. _____

Random Sample Location _____ No _____ Yes

**COMMENTS:**

_____

_____

_____

_____

TP-002 (REV 1)
January 31, 2003

Completed by: _____
Checked by: _____

Designation: E 1728 – 02

# Standard Practice for Collection of Settled Dust Samples Using Wipe Sampling Methods for Subsequent Lead Determination[1]

This standard is issued under the fixed designation E 1728; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

## 1. Scope

1.1 This practice covers the collection of settled dust on surfaces using the wipe sampling method. These samples are collected in a manner that will permit subsequent extraction and determination of lead using laboratory analysis techniques such as atomic spectrometry or electroanalysis.

1.2 This practice does not address the sampling design criteria (that is, sampling plan which includes the number and location of samples) that are used for clearance, lead hazard evaluation, risk assessment, and other purposes. To provide for valid conclusions, sufficient numbers of samples should be obtained as directed by a sampling plan.

1.3 This practice contains notes that are explanatory and are not part of the mandatory requirements of this practice.

1.4 The values stated in SI units are to be regarded as the standard.

1.5 *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.*

## 2. Referenced Documents

2.1 *ASTM Standards:*

D 4840 Guide for Sampling Chain-of-Custody Procedures[2]

E 1605 Terminology Relating to Mitigation and Control of Lead Hazards[2]

E 1613 Test Method for Determination of Lead by Inductively Coupled Plasma Atomic Emission Spectrometry (ICP-AES), Flame Atomic Absorption Spectrometry (FAAS), and Graphite Furnace Atomic Absorption Spectrometry (GFAAS) Techniques[2]

E 1644 Practice for Hot Plate Extraction of Dust Wipe Samples for Determination of Lead[2]

E 1792 Specification for Wipe Sampling Materials for Lead in Surface Dust[2]

E 1979 Practice for Ultrasonic Extraction of Paint, Dust, Soil, and Air Samples for Subsequent Determination of Lead[2]

E 2051 Practice for the Determination of Lead in Paint, Settled Dust, Soil, and Air Particulate by Field-Portable Electroanalysis[2]

2.2 *Federal Regulations:*

40 CFR 745.63, U.S. Environmental Protection Agency (EPA) "403 Rule": Federal Register, Vol 66(4), 5 Jan. 2001, p. 1206[3]

## 3. Terminology

3.1 For definitions of terms not listed here, see Terminology E 1605.

3.2 *Definitions:*

3.2.1 *batch, n*—a group of field or quality control (QC) samples that are collected or processed together at the same time using the same reagents and equipment.

3.2.2 *sampling location, n*—a specific area within a sampling site that is subjected to sample collection.

3.2.2.1 *Discussion*—Multiple sampling locations are commonly designated for a single sampling site (see 3.2.3).

3.2.3 *sampling site, n*—a local geographic area that contains the sampling locations (see 3.2.2).

3.2.3.1 *Discussion*—A sampling site is generally limited to an area that is easily covered by walking.

3.2.4 *wipe, n*—a disposable towellette that is moistened with a wetting agent. E 1792

3.2.4.1 *Discussion*—These towellettes are used to collect a sample of settled dust on a surface for subsequent lead analysis.

3.3 *Definitions of Terms Specific to This Standard:*

3.3.1 *field blank, n*—a wipe (see 3.2.4) that is exposed to the same handling as field samples except that no sample is collected (no surface is actually wiped).

3.3.1.1 *Discussion*—Analysis results from field blanks provide information on the analyte background level in the wipe combined with the potential contamination experienced by samples collected within the batch (see 3.2.1) resulting from handling.

[1] This practice is under the jurisdiction of ASTM Committee E06 on Performance of Buildings and is the direct responsibility of Subcommittee E06.23 on Control and Mitigation of Lead Hazards.

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[2] *Annual Book of ASTM Standards*, Vol 04.11.

[3] Available from United States Environmental Protection Agency (EPA), Ariel Rios Bldg., 1200 Pennsylvania Ave., NW, Washington, DC 20460, www.epa.org.





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## 4. Summary of Practice

4.1 Wipe samples of settled dust are collected on surfaces from areas of known dimensions with wipes meeting Specification E 1792, using a specified pattern of wiping.

4.2 The collected wipes are then ready for subsequent sample preparation and analysis by procedures such as Practices E 1644, Practice E 1979, Practice E 2051, and Test Method E 1613.

## 5. Significance and Use

5.1 This practice is intended for the collection of settled dust samples in and around buildings and related structures for the subsequent determination of lead content in a manner consistent with that described in the HUD Guidelines[4] and 40 CFR 745.63 (EPA 403 Rule). The practice is meant for use in the collection of settled dust samples that are of interest in clearance, hazard assessment, risk assessment, and other purposes.

5.2 Use of different pressures applied to the sampled surface along with the use of different wiping patterns contribute to collection variability. Thus, the sampling result can vary between operators performing collection from identical surfaces as a result of collection variables. Collection for any group of sampling locations at a given sampling site is best when limited to a single operator.

5.3 This practice is recommended for the collection of settled dust samples from hard, relatively smooth nonporous surfaces. This practice is less effective for collecting settled dust samples from surfaces with substantial texture such as rough concrete, brickwork, textured ceilings, and soft fibrous surfaces such as upholstery and carpeting.

## 6. Apparatus and Materials

6.1 *Sampling Templates*—One or more of the following: A 30 by 30 cm (approximately 1 $ft^2$) reusable aluminum or plastic, or disposable cardboard or plastic template, (full-square, rectangular, square "U-shaped," rectangular "U-shaped," and "L-shaped") or templates of alternative areas having accurately known dimensions (see Notes 1 and 2).

NOTE 1—For most surfaces, it is recommended to collect settled dust from a minimum of a 100 $cm^2$ area to provide sufficient material for laboratory analysis.[5] However, areas larger than 30 by 30 cm may be appropriate for surfaces having little or no visible settled dust and a smaller sampling area may be appropriate for surfaces with very high levels of visible settled dust.

NOTE 2—Templates should be capable of lying flat on a surface.

6.2 *Wipes*, meeting the specifications of Specification E 1792; see 3.2.4 for definition.

6.3 *Sample Containers*, resealable, rigid-walled, 50-mL minimum volume.

NOTE 3—Screw-top plastic centrifuge tubes are an example of a suitable rigid-walled sample container.

NOTE 4—Use of a resealable plastic bag for holding and transporting the settled dust wipe sample is not recommended due to the potential losses of settled dust within the plastic bag during transportation and laboratory handling. Quantitative removal and processing of the settled dust wipe sample by the laboratory is significantly improved through the use of resealable rigid-walled containers.

6.4 *Measuring Tool*, tape or ruler, capable of measuring to the nearest ±1 mm.

6.5 *Plastic Gloves*, powderless

6.6 *Cleaning Cloths*, for cleaning of templates and other equipment.

NOTE 5—Wipes used for dust sampling (see 6.2) can be used for cleaning templates and other sampling equipment, but other cleaning cloths or wipes not meeting the specifications of Specification E 1792 may be suitable for this purpose.

6.7 *Adhesive Tape*, suitable for securing the template(s) to the surface(s) to be sampled, and for demarcating sampling areas where templates cannot be used.

NOTE 6—Duct or masking tape, for example, function well for these purposes.

6.8 *Disposable Shoe Covers*, optional.

## 7. Procedure

7.1 Use one of the following two procedures for collecting settled dust samples from each sampling location. For wide, flat locations, use the template-assisted sampling procedure (see 7.1.1). For small locations (for example, a window sill or door jamb), use the confined-area sampling procedure (see 7.1.2).

NOTE 7—Lead contamination problems during field sampling can be severe and may affect settled dust analysis results. Contamination can be minimized through frequent changing of gloves, use of shoe covers (see 6.8), and regular cleaning of sampling equipment with cleaning cloths (see 6.6). Use of disposable shoe covers between different buildings and removal of them prior to entering vehicles can be helpful to minimize inadvertent transfer of settled dust from one location to another.

7.1.1 *Template-Assisted Sampling Procedure*:

7.1.1.1 Don a pair of clean, powderless, plastic gloves (see 6.5 and Note 7).

7.1.1.2 Carefully place a clean template on the surface to be sampled in a manner that minimizes disturbance of settled dust at the sampling location. ~~Tape the outside edge of the template to prevent the template from moving during sample collection~~. EMA 4/22/03

7.1.1.3 Obtain a packaged wipe (see 6.2) and, if there is a possibility for the package to be contaminated with dust, clean the package with a cleaning cloth (see 6.6).

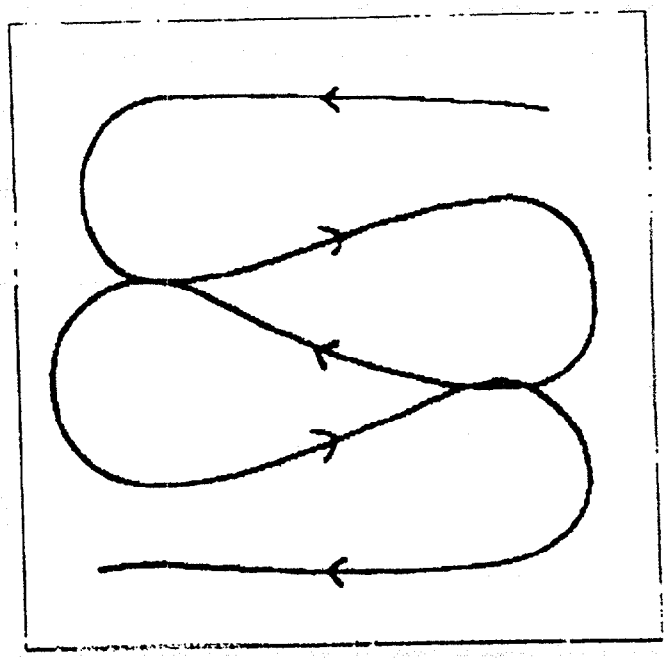
7.1.1.4 Remove the wipe from its package, and inspect the wipe to ensure that it is fully wetted and not contaminated with fungus, dust or other material. Discard the wipe if it is found to be too dry or contaminated, or both.

7.1.1.5 Using an open flat hand with the fingers together, place the wipe on the surface to be sampled. Wipe the selected surface area, side to side, in an overlapping "S" pattern while applying pressure to the fingertips (see Fig. 1). Wipe the surface so that the entire selected surface area is covered. Perform the wiping procedure using the fingers and not the palm of the hand. The front leading edge of the wipe shall always be pushed forward.

Wet EMA 4/22/03 the wipe w/ DI water from a squeeze ~~spray~~ bottle. EMA 4/22/03 EMA 4/24/03

[4] *Guidelines for the Evaluation and Control of Lead-Based Paint Hazards in Housing*, U.S. Department of Housing and Urban Development (HUD), Washington, DC, 1995.

[5] Sussell, A., Hart, C., Wild, D. and Ashley, K., "An Evaluation of Worker Lead Exposures and Cleaning Effectiveness During Removal of Deteriorated Lead-Based Paint," *Applied Occupational and Environmental Hygiene*, Vol 14, 1999, pp. 177–185.



NOTE 1—Only the center of the wipe path is shown, not the entire wiping width. The up-and-down overlapping "S" pattern wiping path is the same path turned 90°. The example shown is for right-handed wipe sampling; the mirror image of the figure would illustrate the path left-handed sampling.

**FIG. 1 Example of a Side-to-Side Overlapping "S" Pattern Wiping Path**

7.1.1.6 Repeat 7.1.1.5 using a different brand of wipe if the wipe curls up or significantly changes shape (wrinkles, crumples, kinks and the like) during the wipe process.

NOTE 8—Some surfaces may cause some specific brands of wipes to curl-up or otherwise significantly change shape during the wiping process but not affect other wipes. A type of wipe that essentially maintains it shape must be selected for each surface sampled.

7.1.1.7 Fold the wipe in half with the collected dust side folded inward and repeat the preceding wiping procedure (7.1.1.6) within the selected sampling area using an up and down overlapping "S" pattern (see Fig. 1 and Note 9).

NOTE 9—Wipes are folded to envelop the collected dust within the wipe, to avoid collected dust loss, and to expose a clean wipe surface for further dust collection. For areas containing large amounts of settled dust, care must be taken during wiping to capture all the dust within the wipe.

7.1.1.8 Fold the wipe in half again with the collected dust side folded inward and repeat the wiping procedure one more time, concentrating on collecting settled dust from all corners within the selected surface area (see Note 9).

7.1.1.9 Fold the wipe again with the collected dust side folded inward and insert the folded wipe into a sample container (see 6.3).

7.1.1.10 Label the sample container with sufficient information to uniquely and indelibly identify the sample, and record the dimensions (in centimetres) of the selected sampling area (the internal template dimensions). Discard the gloves.

7.1.2 *Confined Area Sampling Procedure*:

7.1.2.1 Don a pair of clean, powderless, plastic gloves (see 6.5 and Note 7).

7.1.2.2 Mark the defined area to be sampled with adhesive tape (see 6.7) being careful not to disturb the settled dust, and measure the area to be sampled using the measuring tool (see 6.4).

7.1.2.3 Obtain a packaged wipe (see 6.2) and, if there is a possibility for the package to be contaminated with dust, clean the package with a cleaning cloth (see 6.6).

7.1.2.4 Remove the wipe from its package, and inspect the wipe to ensure that it is fully wetted and not contaminated with fungus, dust or other material. Discard the wipe if it is found to be too dry or contaminated, or both.

7.1.2.5 Holding the fingers together and flat against the selected surface area, place the wipe on the surface to be sampled. Wipe the measured surface in one direction. Apply pressure to the fingers while wiping the surface. Perform the wiping procedure using the fingers and not the palm of the hand. The front leading edge of the wipe shall always be pushed forward.

7.1.2.6 Fold the wipe in half with the collected dust side folded inward. Repeat the preceding wiping procedure (7.1.2.5) in the reverse direction within the selected sampling area on one side of the folded wipe (see Note 9).

7.1.2.7 Fold the wipe in half with the collected dust side folded inward and repeat the preceding wiping procedure (7.1.2.6) one more time, concentrating on collecting settled

dust from all corners within the selected sampling area (see Note 9).

7.1.2.8 Fold the wipe again with the sample side folded inward and insert the folded wipe into a sample container.

7.1.2.9 Label the sample container with sufficient information to uniquely and indelibly identify the sample. Measure and record the dimensions (in centimetres) of the selected sampling area (that is, the area actually wiped during sample collection). Discard the gloves.

7.2 Collect field blanks at a minimum frequency of 5 % (or 1 for every 20 field wipe samples collected). The minimum number of field blanks to collect for each batch of wipe samples used is three. Place field blanks in sample containers and label these samples in the same fashion as the collected surface dust samples (as per 7.1.1.10 or 7.1.2.9).

7.3 Follow sampling chain of custody procedures to ensure sample traceability. Ensure that the documentation which accompanies the samples is suitable for a chain of custody to be established in accordance with Guide D 4840.

## 8. Records

8.1 Field data related to sample collection shall be documented in a sample log form or field notebook (see Note 10). If field notebooks are used, then they shall be bound with prenumbered pages. All entries on sample data forms and field notebooks shall be made using ink with the signature and date of entry. Any entry errors shall be corrected by using only a single line through the incorrect entry (no scratch outs) accompanied by the initials of the person making the correction, and the date of the correction (see Note 11).

NOTE 10—Field notebooks are useful for recording field data even when preprinted sample data forms are used.

NOTE 11—These procedures are important to properly document and trace field data.

8.2 At a minimum, the following information shall be documented:

8.2.1 Project or client name, address, and city/state location.

8.2.2 General sampling site description.

8.2.3 Information as to what specific collection protocol was used.

8.2.4 Information as to what specific type or brand of wipes was used, including manufacturer and lot number.

8.2.5 Information on quality control (QC) samples: which samples are associated with what group of field blanks.

8.2.6 For each sample collected (including field blanks): an individual and unique sample identifier, dimensions of the area sampled (in centimetres), the calculated area sampled (in square centimetres), and date of collection. This information shall be recorded on the sample container in addition to the field documentation.

8.2.7 For each sample collected: name of person collecting the sample and specific sampling location information from which the sample was removed.

## 9. Keywords

9.1 lead; sample collection; settled dust; wipe





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# APPENDIX D

## Air Sampling Results

## Personal Breathing Zone Sampling Results

| 8-hour TWA Result ($\mu g/m^3$) | Project Sample ID | Location |
|---|---|---|
| <0.005 | 710B11048P | C-710 Room B11 |
| <0.005 | 400PUL060P | C-400 East side |
| <0.005 | 400PUL061P | C-400 East side |
| <0.005 | 400LAU042P | C-400 West side |
| <0.005 | 400LAU043P | C-400 West side |
| <0.005 | 400LAU055P | C-400 West side Exhaust Ventilation |
| <0.006 | 720MEZ063P | C-720 Mezzanine Offices |
| <0.005 | 720GS045P | C-720 Gauge Shop |
| <0.005 | 720MS090P | C-720 Machine Shop |
| <0.005 | 720MS092P | C-720 Machine Shop |
| <0.005 | 720MS120P | C-720 Machine Shop Roof |
| <0.005 | 720CS038P | C-720-C Converter Shop |
| <0.005 | 746AES133P | C-746-A East Smelter |
| <0.005 | 746AES134P | C-746-A East Smelter |
| <0.005 | 746AWS045P | C-746-A West Smelter |
| <0.005 | 746AWS046P | C-746-A West Smelter |

## Area Air Sampling Results

| Result ($\mu g/m^3$) | Project Sample ID | Location |
|---|---|---|
| <0.01 | 710B11050A | C-710 Room B11 |
| <0.01 | 400PUL063A | C-400 East side |
| <0.01 | 400PUL064A | C-400 East side |
| <0.01 | 400PUL065A | C-400 East side |
| <0.01 | 400PUL066A | C-400 East side |
| <0.009 | 400LAU045A | C-400 West side |
| <0.009 | 400LAU046A | C-400 West side |
| <0.01 | 400LAU047A | C-400 West side |
| <0.009 | 400LAU048A | C-400 West side |
| <0.007 | 400GR012A | C-400 Gold Room- DMSA 400-04 |
| <0.01 | 720MEZ065A | C-720 Mezzanine Offices |
| <0.01 | 720MEZ066A | C-720 Mezzanine Offices |
| <0.01 | 720MEZ067AR | C-720 Mezzanine Offices |
| <0.01 | 720MEZ068AR | C-720 Mezzanine Offices |
| <0.01 | 720GS047A | C-720 Gauge Shop |
| <0.007 | 720MS094A | C-720 Machine Shop |
| <0.009 | 720MS096A | C-720 Machine Shop |
| <0.01 | 720MS097A | C-720 Machine Shop |
| <0.008 | 720CS041A | C-720-C Converter Shop |
| <0.007 | 720CS042A | C-720-C Converter Shop |
| <0.01 | 746AES136A | C-746-A East Smelter |
| <0.01 | 746AES137A | C-746-A East Smelter |
| <0.007 | 746AES138A | C-746-A East Smelter |
| <0.01 | 746AWS048A | C-746-A West Smelter |
| <0.01 | 746AWS049A | C-746-A West Smelter |
| <0.003 | 746AWS050A | C-746-A West Smelter |

# APPENDIX E

## List of Terms and Notations Used in Sample Results Tables

List of Terms and Notations Used in Sample Results Tables

* – USEC Laboratory Note: "Duplicate analysis not within control limits"

**FILTER** – matrix for an air sample

**J** – USEC Laboratory Note: "Indicates an estimated value. The result was above the limit of detection, but less than the limit of quantitation."

**MATRIX** – sample matrix

**mg/kg** - milligrams beryllium per kilogram of sample

**N** – USEC Laboratory Note: "Sample spike recovery not within control limits"

**PROJ_SAMPLE_ID** – unique sample number

**RESULTS** – analytical result reported by the laboratory

**RSLTQUAL** – USEC laboratory assigned notations

**SOLID** – matrix for a bulk sample

**U** – USEC Laboratory Note: "Analyte analyzed for but not detected at or below the lowest concentration reported. Results were below the LOD for the instrument used."

**µg/wipe** – micrograms beryllium per wipe. Sample area for all wipe samples was 100 $cm^2$, unless otherwise noted

**µg/filter** – micrograms beryllium per air filter

**WIPE** – matrix for a surface wipe sample

# APPENDIX F-1

# C-710 Building Room B11

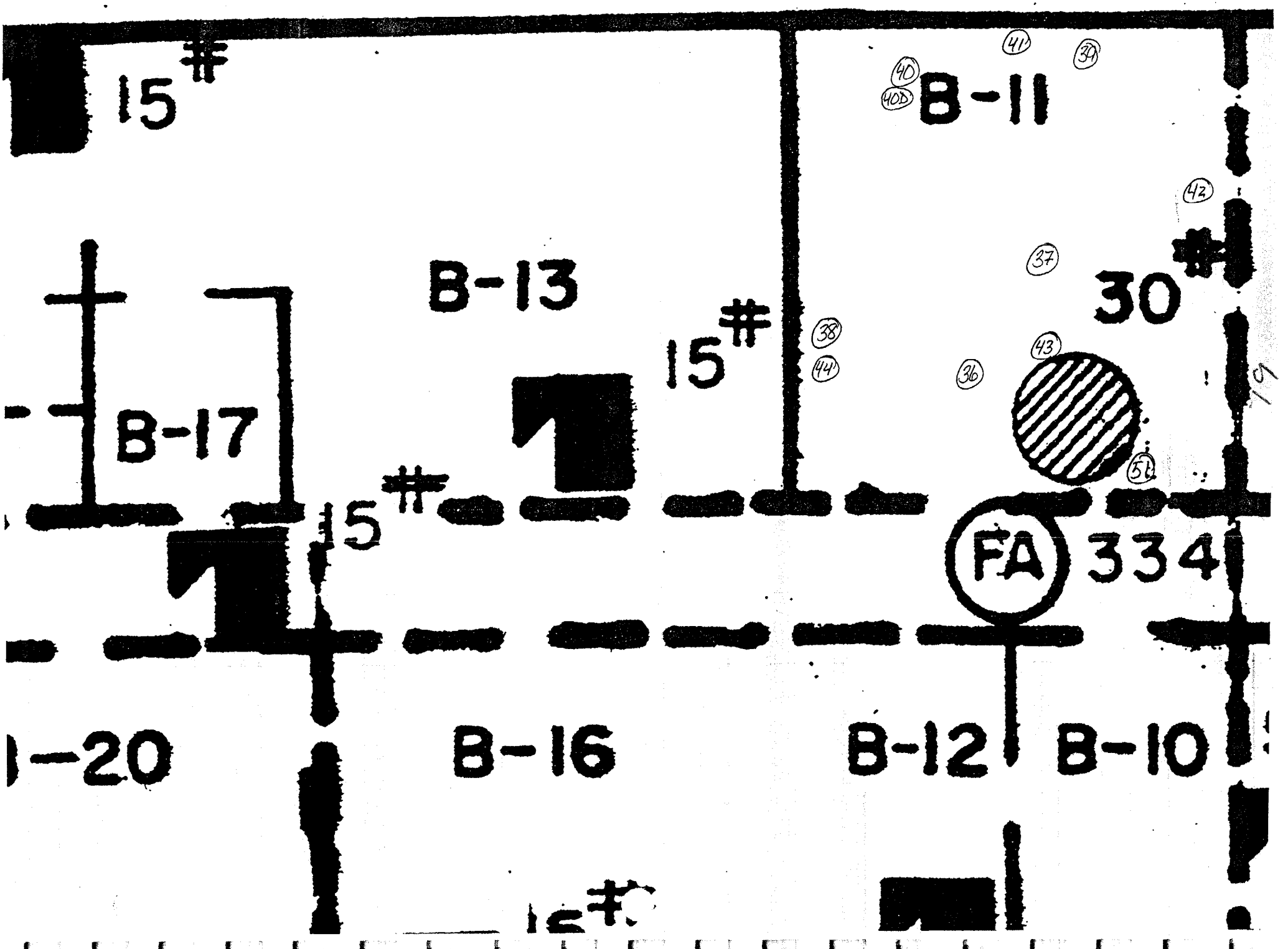
# C-710 Room B11 Machine Shop
## All Samples

| RESULTS | MATRIX | UNITS | PROJ_SAMPLE_ID | RSLTQUAL |
|---|---|---|---|---|
| 0.01 | FILTER | ug/filter | 710B11048P | U |
| 0.01 | FILTER | ug/filter | 710B11050A | U |
| | | | | |
| 0.5 | SOLID | mg/kg | 710B11051B | U |
| 0.5 | SOLID | mg/kg | 710B11052B | U |
| 0.5 | SOLID | mg/kg | 710B11052BD | U |
| 0.5 | SOLID | mg/kg | 710B11053B | U |
| | | | | |
| | **Minimum** | **Maximum** | | |
| **Range** | **0.5** | **0.5** | | |
| | | | | |
| 0.015 | WIPE | ug/wipe | 710B11001W | U |
| 0.015 | WIPE | ug/wipe | 710B11002W | U |
| 0.015 | WIPE | ug/wipe | 710B11003W | U |
| 0.015 | WIPE | ug/wipe | 710B11004W | U |
| 0.015 | WIPE | ug/wipe | 710B11005W | U |
| 0.015 | WIPE | ug/wipe | 710B11006W | U |
| 0.015 | WIPE | ug/wipe | 710B11007W | U |
| 0.015 | WIPE | ug/wipe | 710B11008W | U |
| 0.015 | WIPE | ug/wipe | 710B11009W | U |
| 0.015 | WIPE | ug/wipe | 710B11010W | U |
| 0.015 | WIPE | ug/wipe | 710B11010WD | U |
| 0.015 | WIPE | ug/wipe | 710B11011W | U |
| 0.015 | WIPE | ug/wipe | 710B11012W | U |
| 0.015 | WIPE | ug/wipe | 710B11013W | U |
| 0.015 | WIPE | ug/wipe | 710B11014W | U |
| 0.015 | WIPE | ug/wipe | 710B11015W | U |
| 0.015 | WIPE | ug/wipe | 710B11016W | U |
| 0.015 | WIPE | ug/wipe | 710B11017W | U |
| 0.015 | WIPE | ug/wipe | 710B11018W | U |
| 0.015 | WIPE | ug/wipe | 710B11019W | U |
| 0.015 | WIPE | ug/wipe | 710B11020W | U |
| 0.015 | WIPE | ug/wipe | 710B11021W | U |
| 0.015 | WIPE | ug/wipe | 710B11022W | U |
| 0.015 | WIPE | ug/wipe | 710B11023W | U |
| 0.015 | WIPE | ug/wipe | 710B11024W | U |
| 0.015 | WIPE | ug/wipe | 710B11025W | U |
| 0.015 | WIPE | ug/wipe | 710B11026W | U |
| 0.015 | WIPE | ug/wipe | 710B11027W | U |
| 0.015 | WIPE | ug/wipe | 710B11028W | U |
| 0.015 | WIPE | ug/wipe | 710B11029W | U |
| 0.015 | WIPE | ug/wipe | 710B11030W | U |
| 0.015 | WIPE | ug/wipe | 710B11030WD | U |
| 0.015 | WIPE | ug/wipe | 710B11031W | U |
| 0.015 | WIPE | ug/wipe | 710B11032W | U |
| 0.015 | WIPE | ug/wipe | 710B11033W | U |
| 0.015 | WIPE | ug/wipe | 710B11034W | U |
| 0.015 | WIPE | ug/wipe | 710B11035W | U |
| 0.015 | WIPE | ug/wipe | 710B11036W | U |

# C-710 Room B11 Machine Shop
## All Samples

| RESULTS | MATRIX | UNITS | PROJ_SAMPLE_ID | RSLTQUAL |
|---|---|---|---|---|
| 0.015 | WIPE | ug/wipe | 710B11037W | U |
| 0.015 | WIPE | ug/wipe | 710B11038W | U |
| 0.015 | WIPE | ug/wipe | 710B11039W | U |
| 0.015 | WIPE | ug/wipe | 710B11040W | U |
| 0.015 | WIPE | ug/wipe | 710B11040WD | U |
| 0.015 | WIPE | ug/wipe | 710B11041W | U |
| 0.015 | WIPE | ug/wipe | 710B11042W | U |
| 0.015 | WIPE | ug/wipe | 710B11043W | U |
| 0.015 | WIPE | ug/wipe | 710B11044W | U |
| | | | | |
| | **Minimum** | **Maximum** | | |
| **Range** | **0.015** | **0.015** | | |

Ground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40
40D
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42
B-13
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334
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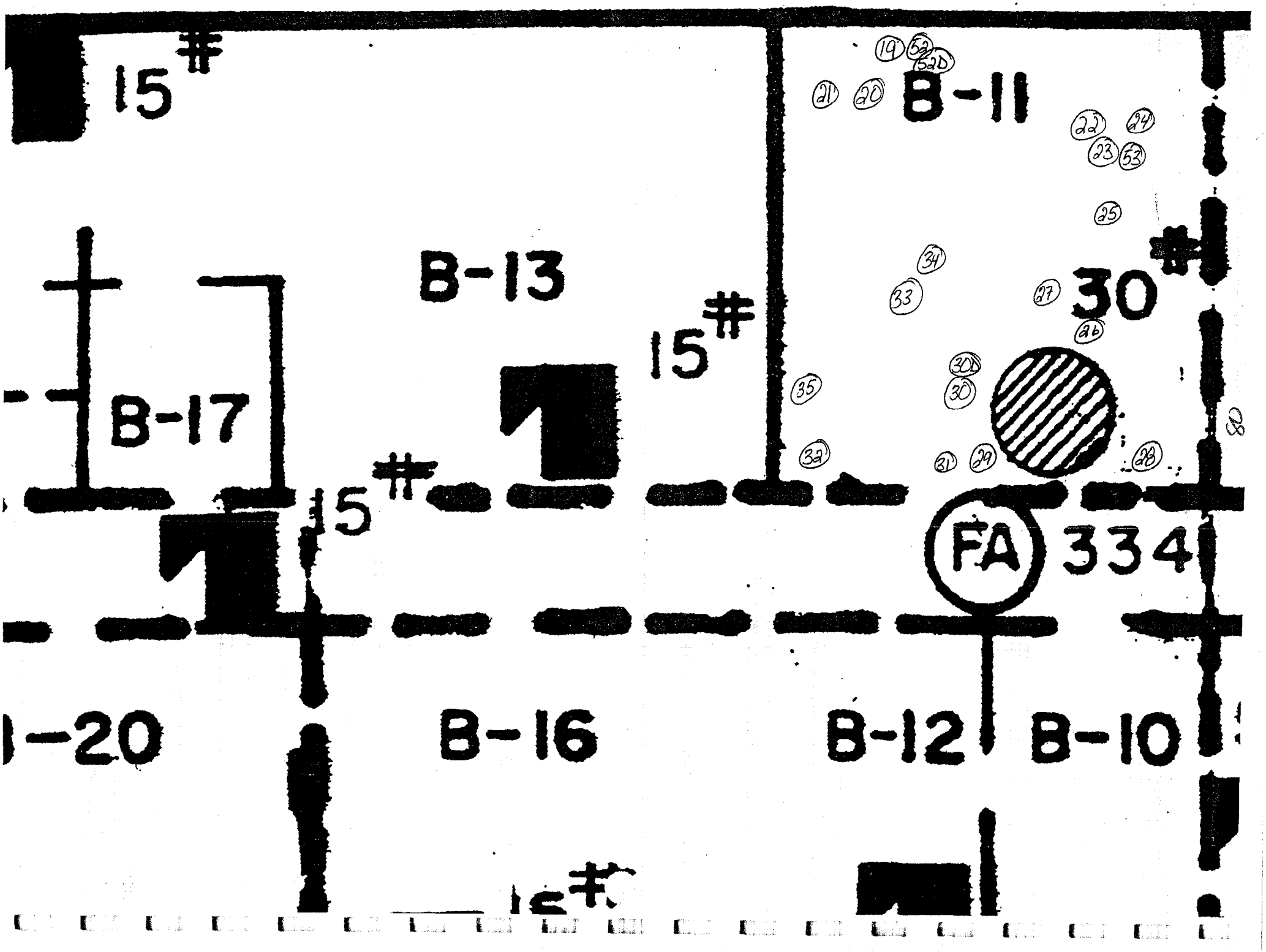
B-12
B-10
1-20


Elevated
15#
B-11
19
52
52D
21
20
22
24
23
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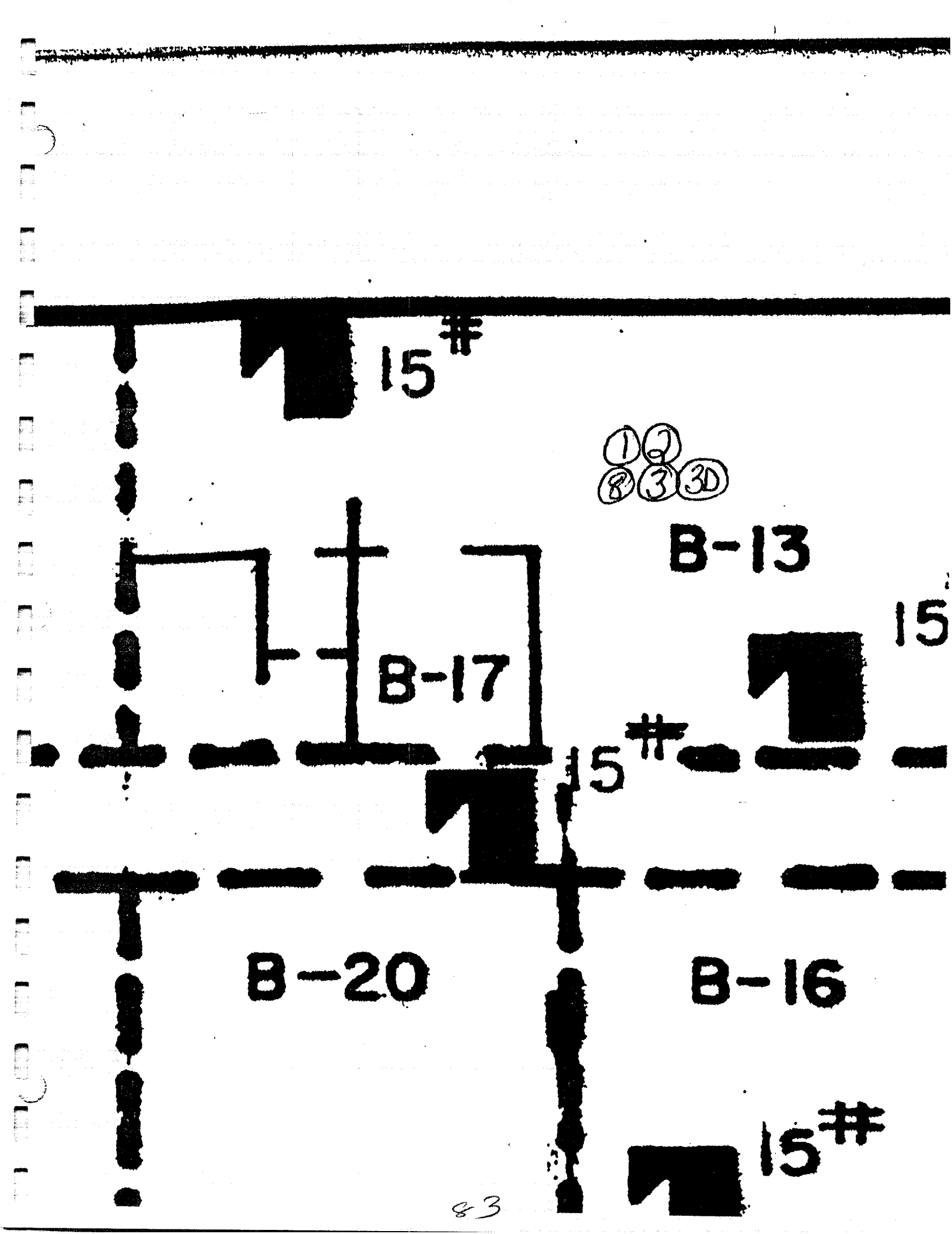
25
B-13
15#
34
33
27
30#
26
30D
30
35
32
31
29
28
B-17
15#
FA
334
B-16
B-12
B-10

# APPENDIX F-2

# C-710 Building Room B13

# C-710 Room B13
## All Samples

| RESULTS | MATRIX | UNITS | PROJ_SAMPLE_ID | RSLTQUAL | LOCATION |
|---|---|---|---|---|---|
| **3.61** | **SOLID** | **mg/kg** | **710B22B13008B** | | **Pit below tensite test table in B13** |
| | | | | | |
| | **Minimum** | **Maximum** | | | |
| **Range** | **3.61** | **3.61** | | | |
| | | | | | |
| 0.015 | WIPE | ug/wipe | 710B22B13001W | U | |
| 0.015 | WIPE | ug/wipe | 710B22B13002W | U | |
| 0.015 | WIPE | ug/wipe | 710B22B13003W | U | |
| 0.015 | WIPE | ug/wipe | 710B22B13003WD | U | |
| | | | | | |
| | **Minimum** | **Maximum** | | | |
| **Range** | **0.015** | **0.015** | | | |

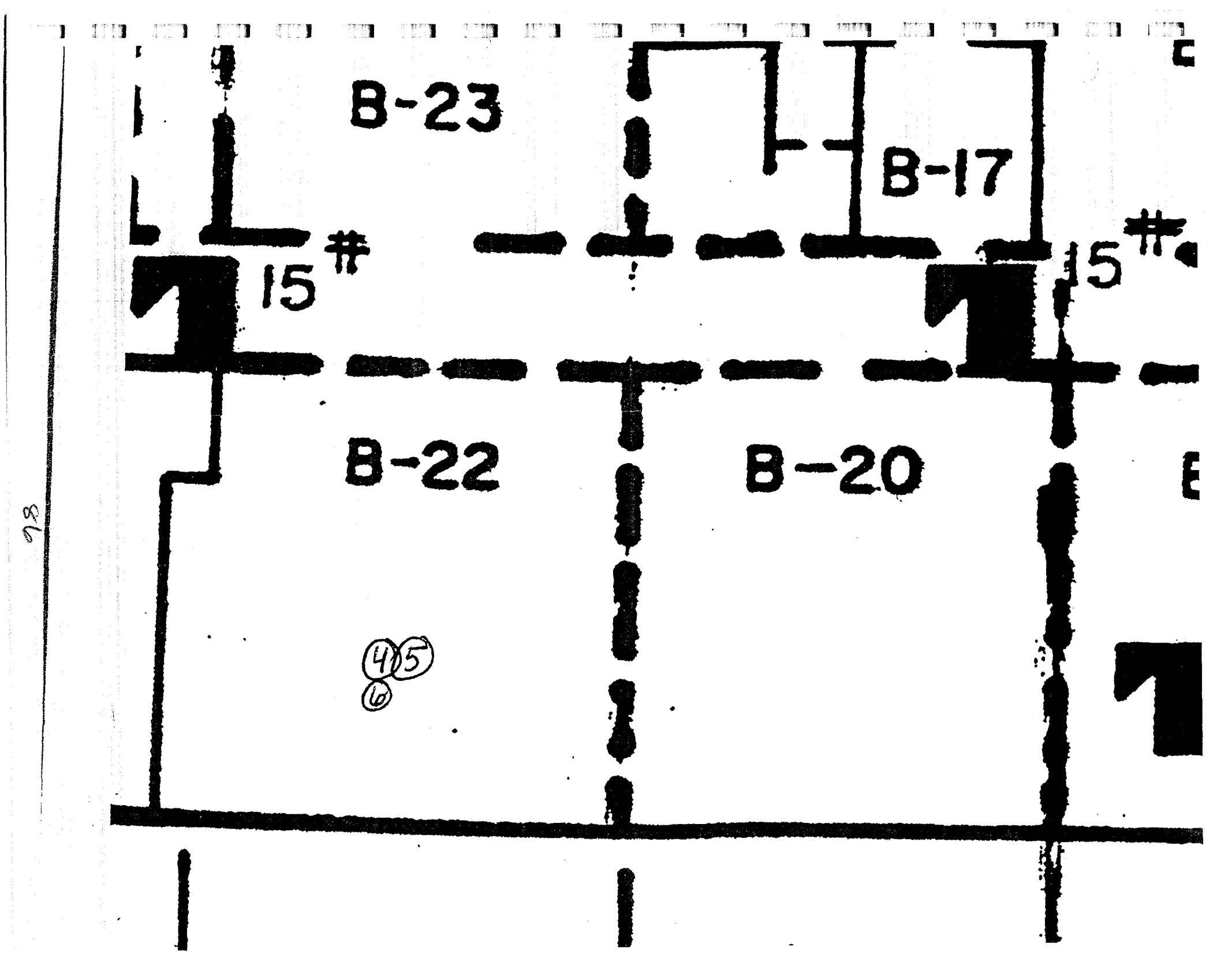

15#
1
2
8
3
3D
B-13
B-17
15
15#
B-20
B-16
15#

# APPENDIX F-3

# C-710 Building Room B22

# C-710 Room B22
## All Samples

| RESULTS | MATRIX | UNITS | PROJ_SAMPLE_ID | RSLTQUAL |
|---|---|---|---|---|
| 0.015 | WIPE | ug/wipe | 710B22B13004W | U |
| 0.015 | WIPE | ug/wipe | 710B22B13005W | U |
| 0.015 | WIPE | ug/wipe | 710B22B13006W | U |
| | | | | |
| | **Minimum** | **Maximum** | | |
| **Range** | **0.015** | **0.015** | | |


B-23
B-17
15 #
15 #
B-22
B-20
4
5
6

# APPENDIX G

## C-720 Building Mezzanine Offices and Material Handling Area

# C-720 Mezzanine Offices
## All Samples

| RESULTS | MATRIX | UNITS | PROJ_SAMPLE_ID | RSLTQUAL |
|---|---|---|---|---|
| **Air** | | | | |
| 0.01 | FILTER | ug/filter | 720MEZ063P | U |
| 0.01 | FILTER | ug/filter | 720MEZ065A | U |
| 0.01 | FILTER | ug/filter | 720MEZ066A | U |
| 0.01 | FILTER | ug/filter | 720MEZ067AR | U |
| 0.01 | FILTER | ug/filter | 720MEZ068AR | U |
| | | | | |
| **Wipe** | | | | |
| 0.023 | WIPE | ug/wipe | 720MEZ001W | J |
| 0.123 | WIPE | ug/wipe | 720MEZ002W | |
| 0.023 | WIPE | ug/wipe | 720MEZ003W | J |
| 0.01 | WIPE | ug/wipe | 720MEZ004W | U |
| 0.01 | WIPE | ug/wipe | 720MEZ005W | U |
| 0.01 | WIPE | ug/wipe | 720MEZ006W | U |
| 0.01 | WIPE | ug/wipe | 720MEZ007W | U |
| 0.01 | WIPE | ug/wipe | 720MEZ008W | U |
| 0.01 | WIPE | ug/wipe | 720MEZ009W | U |
| 0.01 | WIPE | ug/wipe | 720MEZ010W | U |
| 0.01 | WIPE | ug/wipe | 720MEZ010WD | U |
| 0.01 | WIPE | ug/wipe | 720MEZ011W | U |
| 0.01 | WIPE | ug/wipe | 720MEZ012W | U |
| 0.01 | WIPE | ug/wipe | 720MEZ013W | U |
| 0.01 | WiPE | ug/wipe | 720MEZ014W | U |
| 0.01 | WIPE | ug/wipe | 720MEZ015W | U |
| 0.01 | WIPE | ug/wipe | 720MEZ016W | U |
| 0.02 | WIPE | ug/wipe | 720MEZ017W | J |
| 0.01 | WIPE | ug/wipe | 720MEZ018W | U |
| 0.01 | WIPE | ug/wipe | 720MEZ019W | U |
| 0.01 | WIPE | ug/wipe | 720MEZ020W | U |
| 0.01 | WIPE | ug/wipe | 720MEZ020WD | U |
| 0.01 | WIPE | ug/wipe | 720MEZ021W | U |
| 0.023 | WIPE | ug/wipe | 720MEZ022W | J |
| 0.01 | WIPE | ug/wipe | 720MEZ023W | U |
| 0.01 | WIPE | ug/wipe | 720MEZ024W | U |
| 0.01 | WIPE | ug/wipe | 720MEZ025W | U |
| 0.01 | WIPE | ug/wipe | 720MEZ026W | U |
| 0.01 | WIPE | ug/wipe | 720MEZ027W | U |
| 0.01 | WIPE | ug/wipe | 720MEZ028W | U |
| 0.02 | WIPE | ug/wipe | 720MEZ029W | J |
| 0.01 | WIPE | ug/wipe | 720MEZ030W | U |
| 0.01 | WIPE | ug/wipe | 720MEZ030WD | U |
| 0.02 | WIPE | ug/wipe | 720MEZ031W | J |
| 0.01 | WIPE | ug/wipe | 720MEZ032W | U |
| 0.02 | WIPE | ug/wipe | 720MEZ033W | J |
| 0.01 | WIPE | ug/wipe | 720MEZ034W | U |
| 0.01 | WIPE | ug/wipe | 720MEZ035W | U |
| 0.01 | WIPE | ug/wipe | 720MEZ036W | U |
| 0.01 | WIPE | ug/wipe | 720MEZ037W | U |
| 0.01 | WIPE | ug/wipe | 720MEZ038W | U |
| 0.01 | WIPE | ug/wipe | 720MEZ039W | U |

# C-720 Mezzanine Offices
## All Samples

| RESULTS | MATRIX | UNITS | PROJ_SAMPLE_ID | RSLTQUAL |
|---|---|---|---|---|
| 0.01 | WIPE | ug/wipe | 720MEZ040W | U |
| 0.01 | WIPE | ug/wipe | 720MEZ041W | U |
| 0.01 | WIPE | ug/wipe | 720MEZ042W | U |
| 0.01 | WIPE | ug/wipe | 720MEZ043W | U |
| 0.01 | WIPE | ug/wipe | 720MEZ044W | U |
| 0.01 | WIPE | ug/wipe | 720MEZ045W | U |
| 0.01 | WIPE | ug/wipe | 720MEZ046W | U |
| 0.01 | WIPE | ug/wipe | 720MEZ047W | U |
| 0.01 | WIPE | ug/wipe | 720MEZ048W | U |
| 0.01 | WIPE | ug/wipe | 720MEZ049W | U |
| 0.01 | WIPE | ug/wipe | 720MEZ050W | U |
| 0.01 | WIPE | ug/wipe | 720MEZ051W | U |
| 0.01 | WIPE | ug/wipe | 720MEZ052W | U |
| 0.01 | WIPE | ug/wipe | 720MEZ053W | U |
| 0.01 | WIPE | ug/wipe | 720MEZ054W | U |
| 0.01 | WIPE | ug/wipe | 720MEZ055W | U |
| 0.01 | WIPE | ug/wipe | 720MEZ056W | U |
| 0.01 | WIPE | ug/wipe | 720MEZ057W | U |
| 0.01 | WIPE | ug/wipe | 720MEZ058W | U |
| 0.045 | WIPE | ug/wipe | 720MEZ059W | J |
| | | | | |
| | **Minimum** | **Maximum** | | |
| **Range** | **0.01** | **0.123** | | |

# APPENDIX H

## C-400 Building East Side

# C-400 East Side
# All Samples

| RESULTS | MATRIX | UNITS | PROJ_SAMPLE_ID | RSLTQUAL |
|---|---|---|---|---|
| | | **Air** | | |
| 0.01 | FILTER | ug/filter | 400PUL060P | U |
| 0.01 | FILTER | ug/filter | 400PUL061P | U |
| 0.01 | FILTER | ug/filter | 400PUL063A | U |
| 0.01 | FILTER | ug/filter | 400PUL064A | U |
| 0.01 | FILTER | ug/filter | 400PUL065A | U |
| 0.01 | FILTER | ug/filter | 400PUL066A | U |
| | | | | |
| | | **Bulk** | | |
| 0.5 | SOLID | mg/kg | 400PUL067B | U |
| 0.5 | SOLID | mg/kg | 400PUL068B | U |
| 0.5 | SOLID | mg/kg | 400PUL069B | U |
| 0.5 | SOLID | mg/kg | 400PUL070B | U |
| 0.5 | SOLID | mg/kg | 400PUL070BD | U |
| 0.5 | SOLID | mg/kg | 400PUL072B | U |
| | | | | |
| | **Minimum** | **Maximum** | | |
| **Range** | **0.5** | **0.5** | | |
| | | | | |
| | | **Wipe** | | |
| 0.025 | WIPE | ug/wipe | 400PUL001W | *JN |
| 0.025 | WIPE | ug/wipe | 400PUL002W | *JN |
| 0.01 | WIPE | ug/wipe | 400PUL003W | *NU |
| 0.01 | WIPE | ug/wipe | 400PUL004W | *NU |
| 0.01 | WIPE | ug/wipe | 400PUL005W | *NU |
| 0.01 | WIPE | ug/wipe | 400PUL006W | *NU |
| 0.01 | WIPE | ug/wipe | 400PUL007W | *NU |
| 0.025 | WIPE | ug/wipe | 400PUL008W | *JN |
| 0.01 | WIPE | ug/wipe | 400PUL009W | *NU |
| 0.01 | WIPE | ug/wipe | 400PUL010W | *NU |
| 0.01 | WIPE | ug/wipe | 400PUL010WD | NU |
| 0.01 | WIPE | ug/wipe | 400PUL011W | NU |
| 0.01 | WIPE | ug/wipe | 400PUL012W | NU |
| 0.01 | WIPE | ug/wipe | 400PUL013W | NU |
| 0.01 | WIPE | ug/wipe | 400PUL014W | NU |
| 0.025 | WIPE | ug/wipe | 400PUL015W | JN |
| 0.01 | WIPE | ug/wipe | 400PUL016W | NU |
| 0.01 | WIPE | ug/wipe | 400PUL017W | NU |
| 0.025 | WIPE | ug/wipe | 400PUL018W | JN |
| 0.01 | WIPE | ug/wipe | 400PUL019W | NU |
| 0.01 | WIPE | ug/wipe | 400PUL020W | U |
| 0.02 | WIPE | ug/wipe | 400PUL021W | J |
| 0.01 | WIPE | ug/wipe | 400PUL022W | U |
| 0.01 | WIPE | ug/wipe | 400PUL023W | U |
| 0.01 | WIPE | ug/wipe | 400PUL024W | U |
| 0.01 | WIPE | ug/wipe | 400PUL025W | U |
| 0.01 | WIPE | ug/wipe | 400PUL025WD | U |
| 0.01 | WIPE | ug/wipe | 400PUL026W | U |
| 0.02 | WIPE | ug/wipe | 400PUL027W | J |

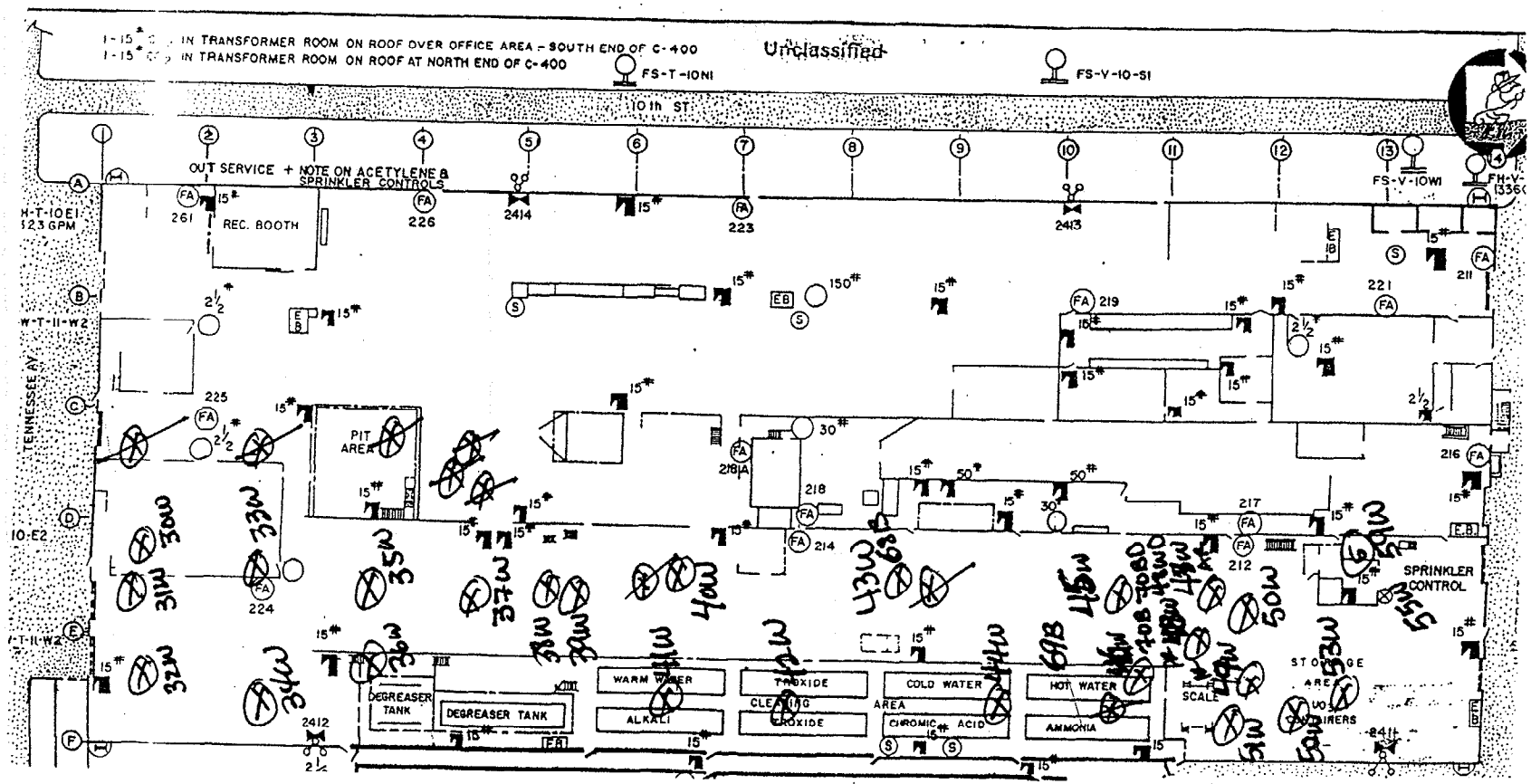
# C-400 East Side
## All Samples

| RESULTS | MATRIX | UNITS | PROJ_SAMPLE_ID | RSLTQUAL |
|---|---|---|---|---|
| 0.02 | WIPE | ug/wipe | 400PUL028W | J |
| 0.025 | WIPE | ug/wipe | 400PUL029W | J |
| 0.05 | WIPE | ug/wipe | 400PUL030W | J |
| 0.1 | WIPE | ug/wipe | 400PUL031W | |
| 0.025 | WIPE | ug/wipe | 400PUL032W | J |
| 0.05 | WIPE | ug/wipe | 400PUL033W | J |
| 0.025 | WIPE | ug/wipe | 400PUL034W | J |
| 0.025 | WIPE | ug/wipe | 400PUL035W | J |
| 0.05 | WIPE | ug/wipe | 400PUL036W | J |
| 0.05 | WIPE | ug/wipe | 400PUL037W | J |
| 0.05 | WIPE | ug/wipe | 400PUL038W | J |
| 0.025 | WIPE | ug/wipe | 400PUL039W | J |
| 0.015 | WIPE | ug/wipe | 400PUL040W | U |
| 0.015 | WIPE | ug/wipe | 400PUL041W | U |
| 0.015 | WIPE | ug/wipe | 400PUL042W | U |
| 0.015 | WIPE | ug/wipe | 400PUL043W | NU |
| 0.015 | WIPE | ug/wipe | 400PUL044W | NU |
| 0.015 | WIPE | ug/wipe | 400PUL045W | NU |
| 0.015 | WIPE | ug/wipe | 400PUL046W | NU |
| 0.015 | WIPE | ug/wipe | 400PUL047W | NU |
| 0.015 | WIPE | ug/wipe | 400PUL048W | NU |
| 0.015 | WIPE | ug/wipe | 400PUL048WD | NU |
| 0.015 | WIPE | ug/wipe | 400PUL049W | NU |
| 0.015 | WIPE | ug/wipe | 400PUL050W | NU |
| 0.028 | WIPE | ug/wipe | 400PUL051W | J |
| 0.028 | WIPE | ug/wipe | 400PUL052W | J |
| 0.053 | WIPE | ug/wipe | 400PUL053W | J |
| 0.01 | WIPE | ug/wipe | 400PUL054W | U |
| 0.028 | WIPE | ug/wipe | 400PUL055W | J |
| 0.028 | WIPE | ug/wipe | 400PUL056W | J |
| 0.028 | WIPE | ug/wipe | 400PUL057W | J |
| 0.028 | WIPE | ug/wipe | 400PUL058W | J |
| 0.103 | WIPE | ug/wipe | 400PUL059W | |
| | | | | |
| | **Minimum** | **Maximum** | | |
| **Range** | **0.01** | **0.103** | | |

C-400 Pulverizer Side

Elevated

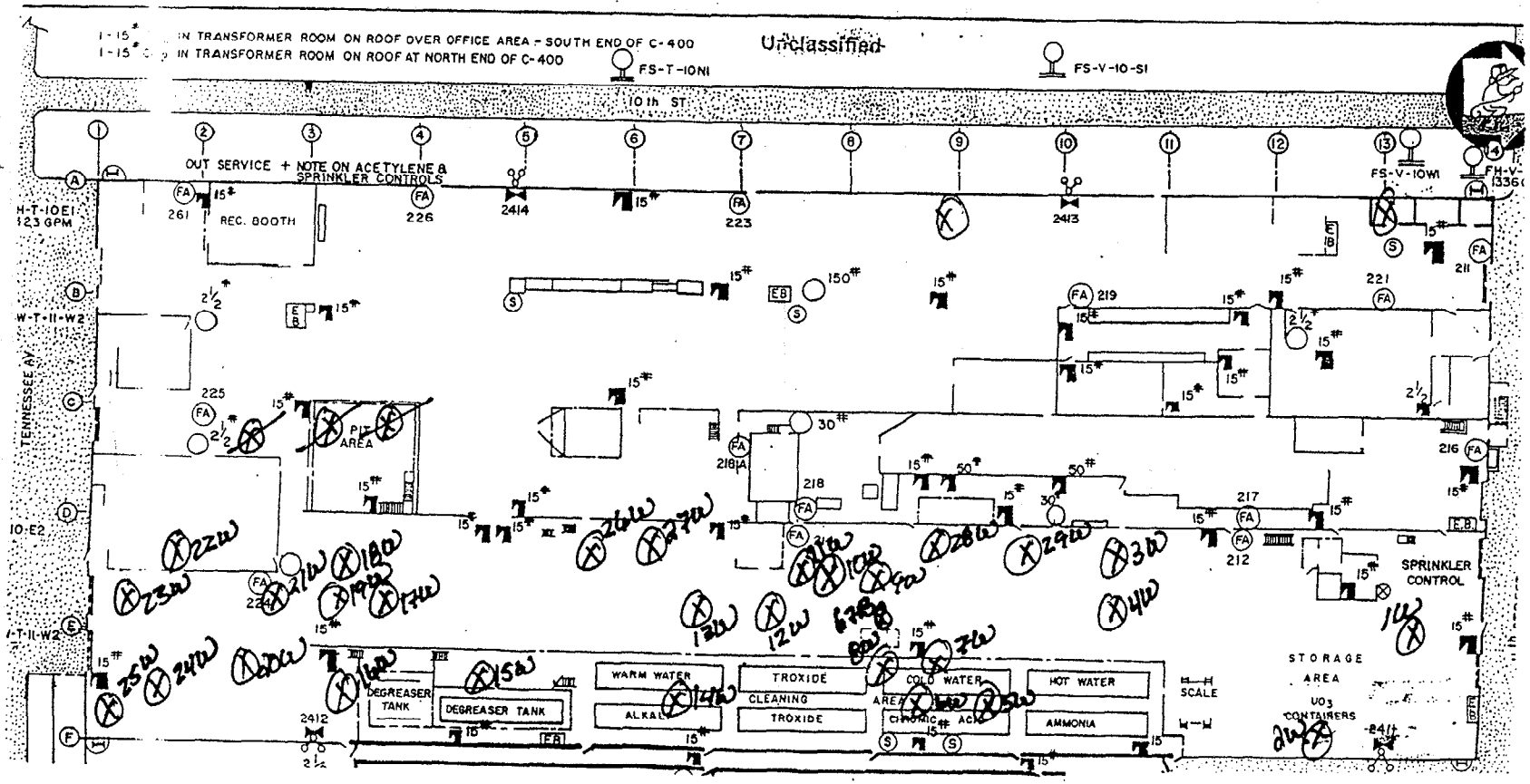
DDED
6 8 10 14 24



C-400 Pulverizer Side

Ground level

Unclassified



# APPENDIX I-1

## C-400 Building West Side

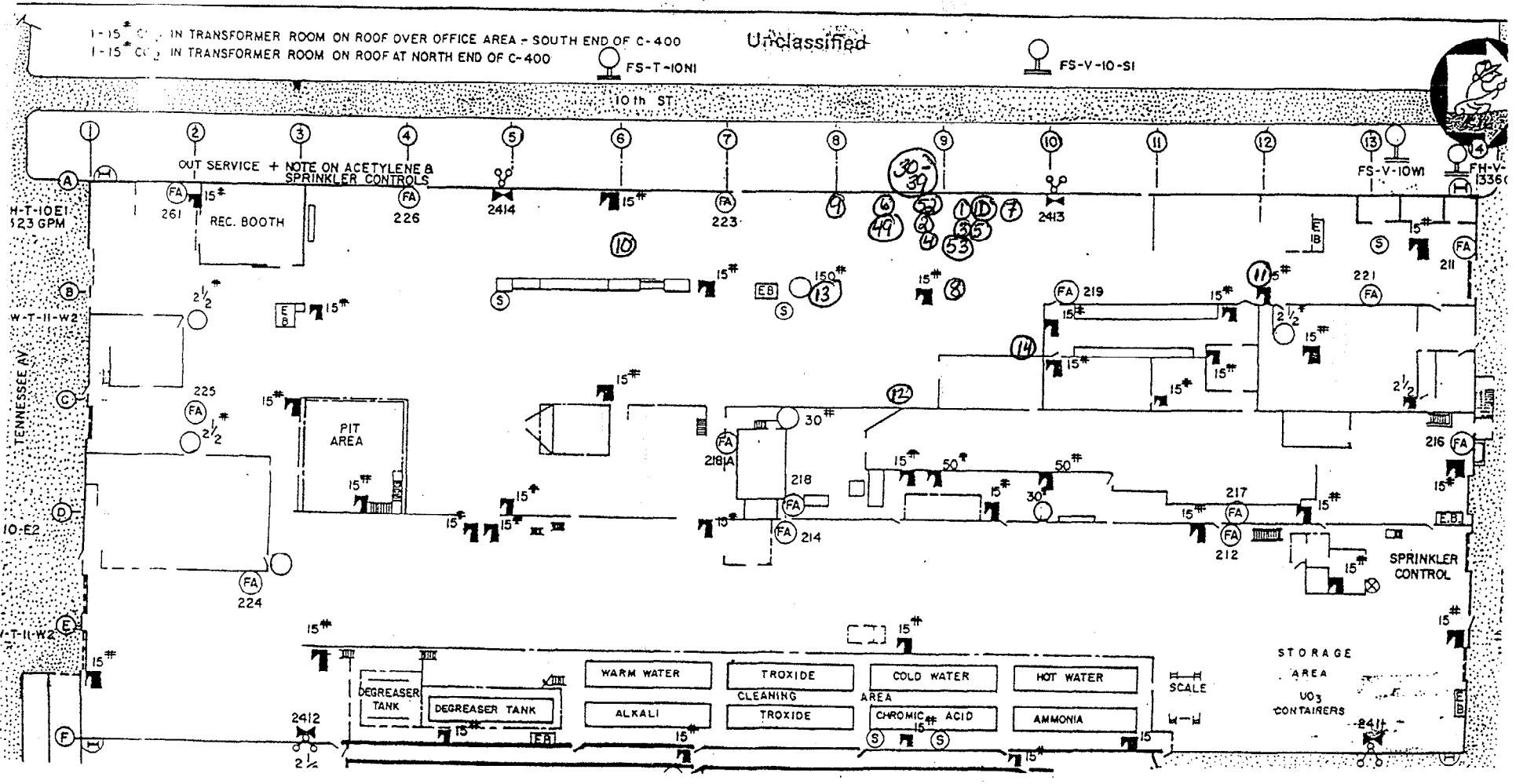
# C-400 West Side
## All Samples

| RESULTS | MATRIX | UNITS | PROJ_SAMPLE_ID | RSLTQUAL | LOCATION |
|---|---|---|---|---|---|
| | | | **Air** | | |
| 0.01 | FILTER | ug/filter | 400LAU042P | U | |
| 0.01 | FILTER | ug/filter | 400LAU043P | U | |
| 0.01 | FILTER | ug/filter | 400LAU045A | U | |
| 0.01 | FILTER | ug/filter | 400LAU046A | U | |
| 0.01 | FILTER | ug/filter | 400LAU047A | U | |
| 0.01 | FILTER | ug/filter | 400LAU048A | U | |
| 0.01 | FILTER | ug/filter | 400LAU055P | U | |
| | | | | | |
| | | | **Bulk** | | |
| 0.5 | SOLID | mg/kg | 400LAU049B | U | |
| 0.5 | SOLID | mg/kg | 400LAU050B | U | |
| 0.5 | SOLID | mg/kg | 400LAU050BD | U | |
| 0.5 | SOLID | mg/kg | 400LAU051B | U | |
| 0.5 | SOLID | mg/kg | 400LAU052B | U | |
| **1.22** | **SOLID** | **mg/kg** | **400LAU053B** | | **Top of control panel in DMSA 400-03** |
| 0.5 | SOLID | mg/kg | 400LAU054B | U | |
| | | | | | |
| | **Minimum** | **Maximum** | | | |
| **Range** | **0.5** | **1.22** | | | |
| | | | | | |
| | | | **Wipe** | | |
| 0.075 | WIPE | ug/wipe | 400LAU001W | | |
| 0.075 | WIPE | ug/wipe | 400LAU001WD | | |
| 0.025 | WIPE | ug/wipe | 400LAU002W | J | |
| 0.055 | WIPE | ug/wipe | 400LAU003W | J | |
| 0.075 | WIPE | ug/wipe | 400LAU004W | | |
| **0.225** | **WIPE** | **ug/wipe** | **400LAU005W** | | **Process piping in DMSA 400-03** |
| 0.025 | WIPE | ug/wipe | 400LAU006W | J | |
| 0.05 | WIPE | ug/wipe | 400LAU007W | J | |
| 0.025 | WIPE | ug/wipe | 400LAU008W | J | |
| 0.025 | WIPE | ug/wipe | 400LAU009W | J | |
| 0.015 | WIPE | ug/wipe | 400LAU010W | U | |
| 0.015 | WIPE | ug/wipe | 400LAU011W | U | |
| 0.015 | WIPE | ug/wipe | 400LAU012W | U | |
| 0.015 | WIPE | ug/wipe | 400LAU013W | U | |
| 0.015 | WIPE | ug/wipe | 400LAU014W | U | |
| 0.015 | WIPE | ug/wipe | 400LAU015W | U | |
| 0.015 | WIPE | ug/wipe | 400LAU016W | U | |
| 0.015 | WIPE | ug/wipe | 400LAU017W | U | |
| 0.015 | WIPE | ug/wipe | 400LAU018W | U | |
| 0.015 | WIPE | ug/wipe | 400LAU019W | U | |
| 0.015 | WIPE | ug/wipe | 400LAU020W | U | |
| 0.015 | WIPE | ug/wipe | 400LAU021W | U | |
| 0.015 | WIPE | ug/wipe | 400LAU022W | U | |
| 0.015 | WIPE | ug/wipe | 400LAU023W | U | |
| 0.015 | WIPE | ug/wipe | 400LAU024W | NU | |
| 0.015 | WIPE | ug/wipe | 400LAU025W | U | |
| 0.015 | WIPE | ug/wipe | 400LAU025WD | U | |

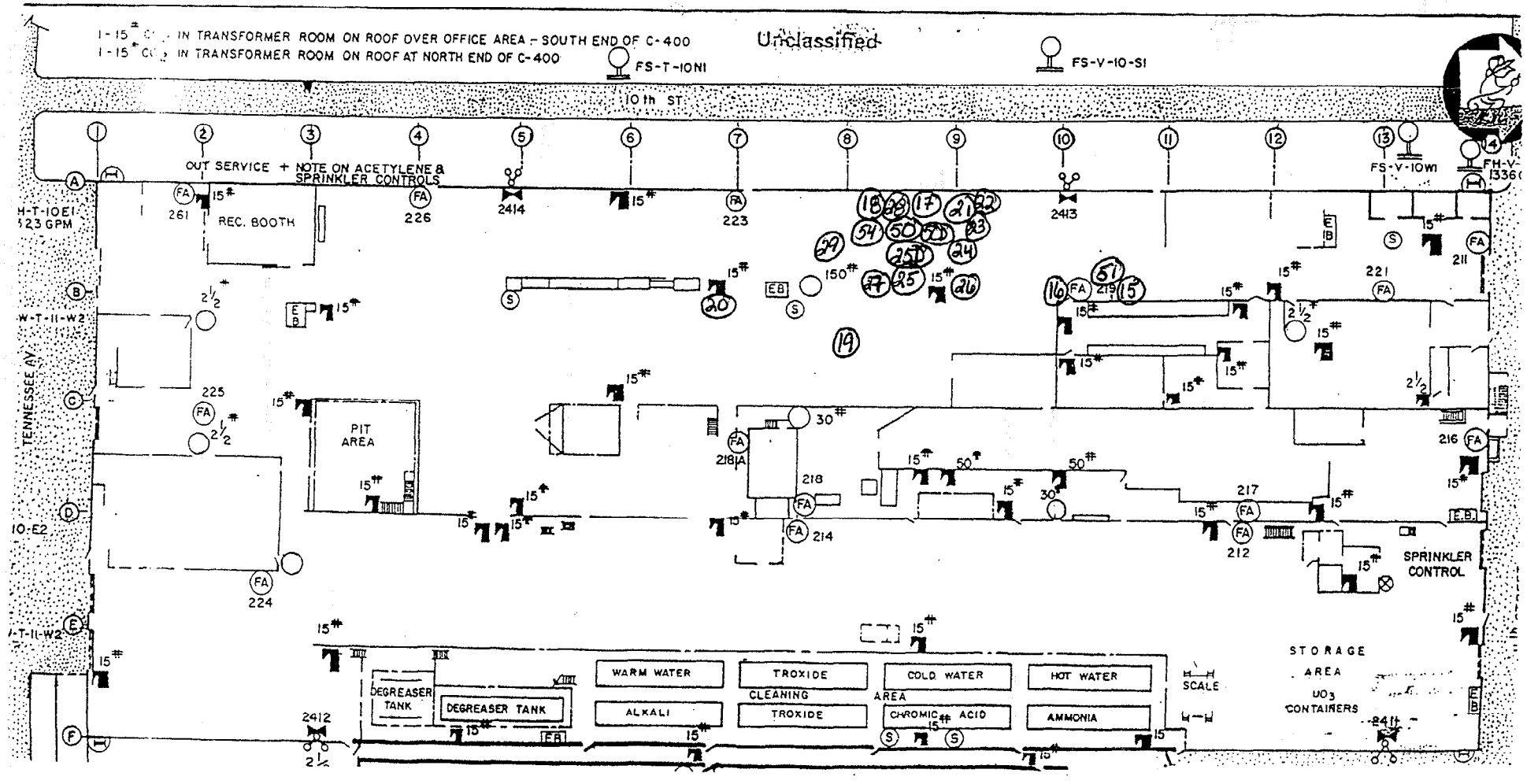
# C-400 West Side
## All Samples

| RESULTS | MATRIX | UNITS | PROJ_SAMPLE_ID | RSLTQUAL | LOCATION |
|---|---|---|---|---|---|
| 0.015 | WIPE | ug/wipe | 400LAU026W | U | |
| 0.015 | WIPE | ug/wipe | 400LAU027W | U | |
| 0.015 | WIPE | ug/wipe | 400LAU028W | U | |
| 0.015 | WIPE | ug/wipe | 400LAU029W | U | |
| **0.205** | **WIPE** | **ug/wipe** | **400LAU030WR** | | **Interior of dust collector associated with north stack and DMSA 400-03** |
| 0.055 | WIPE | ug/wipe | 400LAU031WR | J | |
| 0.03 | WIPE | ug/wipe | 400LAU032WR | J | |
| 0.055 | WIPE | ug/wipe | 400LAU033WR | J | |
| 0.01 | WIPE | ug/wipe | 400LAU034WR | U | |
| 0.155 | WIPE | ug/wipe | 400LAU035WR | | |
| **1.23** | **WIPE** | **ug/wipe** | **400LAU036WR** | | **Interior of dust collector associated with north stack and DMSA 400-03** |
| 0.155 | WIPE | ug/wipe | 400LAU037WR | | |
| 0.033 | WIPE | ug/wipe | 400LAU038WR | J | |
| 0.125 | WIPE | ug/wipe | 400LAU039WR | | |
| | | | | | |
| | **Minimum** | **Maximum** | | | |
| **Range** | **0.01** | **1.23** | | | |

Ground Level



Elevated Line



# APPENDIX I-2

## C-400 Building West Side
## Ground Level and Elevated Surfaces

# C-400 West Side
## Wipe and Bulk Samples from Ground Level and Elevated Surfaces

| RESULTS | MATRIX | UNITS | PROJ_SAMPLE_ID | RSLTQUAL |
|---|---|---|---|---|
| 0.5 | SOLID | mg/kg | 400LAU049B | U |
| 0.5 | SOLID | mg/kg | 400LAU050B | U |
| 0.5 | SOLID | mg/kg | 400LAU050BD | U |
| 0.5 | SOLID | mg/kg | 400LAU051B | U |
| 0.5 | SOLID | mg/kg | 400LAU054B | U |
| | | | | |
| | **Minimum** | **Maximum** | | |
| **Range** | **0.5** | **0.5** | | |
| | | | | |
| 0.025 | WIPE | ug/wipe | 400LAU006W | J |
| 0.05 | WIPE | ug/wipe | 400LAU007W | J |
| 0.025 | WIPE | ug/wipe | 400LAU008W | J |
| 0.025 | WIPE | ug/wipe | 400LAU009W | J |
| 0.015 | WIPE | ug/wipe | 400LAU010W | U |
| 0.015 | WIPE | ug/wipe | 400LAU011W | U |
| 0.015 | WIPE | ug/wipe | 400LAU012W | U |
| 0.015 | WIPE | ug/wipe | 400LAU013W | U |
| 0.015 | WIPE | ug/wipe | 400LAU014W | U |
| 0.015 | WIPE | ug/wipe | 400LAU015W | U |
| 0.015 | WIPE | ug/wipe | 400LAU016W | U |
| 0.015 | WIPE | ug/wipe | 400LAU017W | U |
| 0.015 | WIPE | ug/wipe | 400LAU018W | U |
| 0.015 | WIPE | ug/wipe | 400LAU019W | U |
| 0.015 | WIPE | ug/wipe | 400LAU020W | U |
| 0.015 | WIPE | ug/wipe | 400LAU021W | U |
| 0.015 | WIPE | ug/wipe | 400LAU022W | U |
| 0.015 | WIPE | ug/wipe | 400LAU023W | U |
| 0.015 | WIPE | ug/wipe | 400LAU024W | NU |
| 0.015 | WIPE | ug/wipe | 400LAU025W | U |
| 0.015 | WIPE | ug/wipe | 400LAU025WD | U |
| 0.015 | WIPE | ug/wipe | 400LAU026W | U |
| 0.015 | WIPE | ug/wipe | 400LAU027W | U |
| 0.015 | WIPE | ug/wipe | 400LAU028W | U |
| 0.015 | WIPE | ug/wipe | 400LAU029W | U |
| | | | | |
| | **Minimum** | **Maximum** | | |
| **Range** | **0.015** | **0.05** | | |
| | | | | |
| | | | | |

# APPENDIX I-3

## C-400 Building West Side

## North Stack Exhaust Ventilation System

# C-400 West Side
## Wipe and Bulk Samples from Exhaust Ventilation

| RESULTS | MATRIX | UNITS | PROJ_SAMPLE_ID | RSLTQUAL | LOCATION |
|---|---|---|---|---|---|
| **0.205** | **WIPE** | **ug/wipe** | **400LAU030WR** | | **Interior of dust collector associated with north stack and DMSA 400-03** |
| 0.055 | WIPE | ug/wipe | 400LAU031WR | J | |
| 0.03 | WIPE | ug/wipe | 400LAU032WR | J | |
| 0.055 | WIPE | ug/wipe | 400LAU033WR | J | |
| 0.01 | WIPE | ug/wipe | 400LAU034WR | U | |
| 0.155 | WIPE | ug/wipe | 400LAU035WR | | |
| **1.23** | **WIPE** | **ug/wipe** | **400LAU036WR** | | **Interior of dust collector associated with north stack and DMSA 400-03** |
| 0.155 | WIPE | ug/wipe | 400LAU037WR | | |
| 0.033 | WIPE | ug/wipe | 400LAU038WR | J | |
| 0.125 | WIPE | ug/wipe | 400LAU039WR | | |
| | | | | | |
| | **Minimum** | **Maximum** | | | |
| **Range** | **0.01** | **1.23** | | | |

## Surface Wipe Sample Statistics

**Data Description:** C-400 West Side North Stack Exhaust System

| OEL |
|---|
| 0.2 |

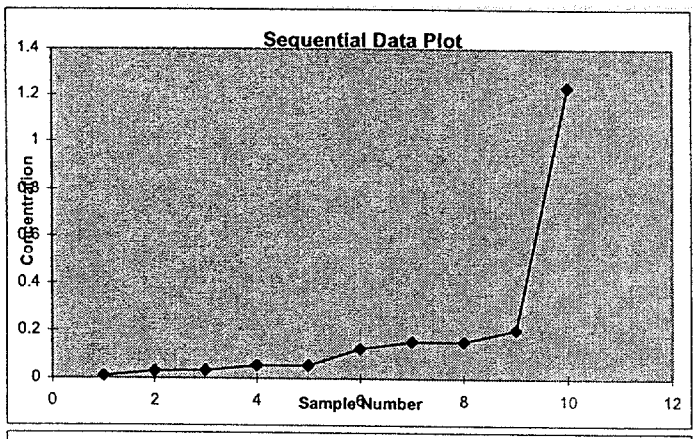
| Sample Data (max n = 50) No less-than (<) or greater-than (>) |
|---|
| 0.01 |
| 0.03 |
| 0.033 |
| 0.055 |
| 0.055 |
| 0.125 |
| 0.155 |
| 0.155 |
| 0.205 |
| 1.23 |

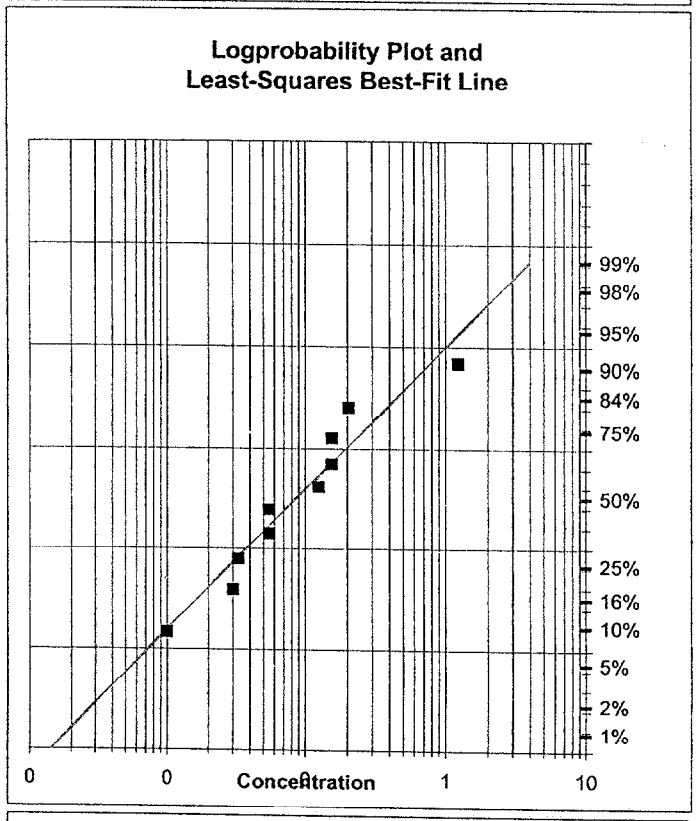
| DESCRIPTIVE STATISTICS | |
|---|---|
| Number of samples (n) | 10 |
| Maximum (max) | 1.23 |
| Minimum (min) | 0.01 |
| Range | 1.22 |
| Percent above OEL (%>OEL) | 20.000 |
| Mean | 0.205 |
| Median | 0.090 |
| Standard deviation (s) | 0.366 |
| Mean of logtransformed data (LN) | -2.451 |
| Std. deviation of logtransformed data (LN) | 1.322 |
| Geometric mean (GM) | 0.086 |
| Geometric standard deviation (GSD) | 3.750 |

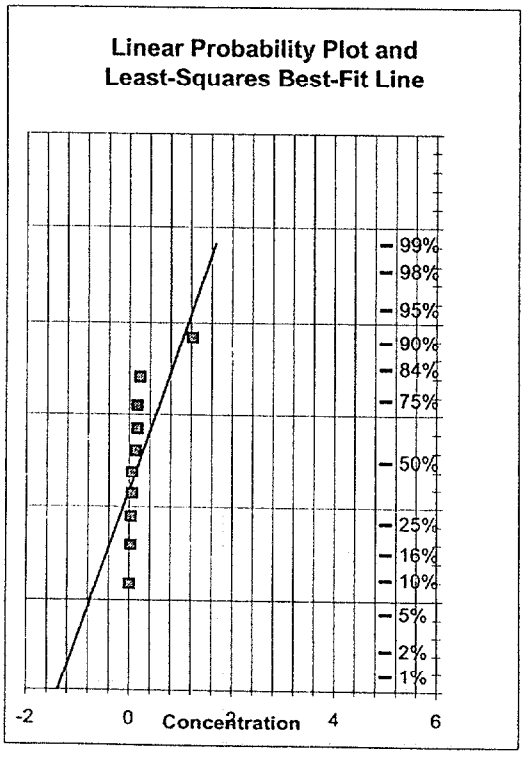
| TEST FOR DISTRIBUTION FIT | |
|---|---|
| W-test of logtransformed data (LN) | 0.960 |
| Lognormal (a = 0.05)? | Yes |
| | |
| W-test of data | 0.530 |
| Normal (a = 0.05)? | No |

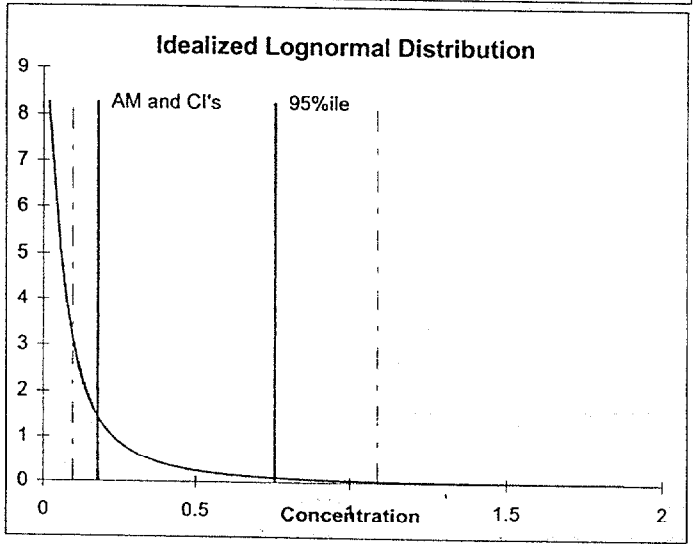
| LOGNORMAL PARAMETRIC STATISTICS | |
|---|---|
| **Estimated Arithmetic Mean - MVUE** | 0.180 |
| $LCL_{1,95\%}$ - Land's "Exact" | 0.095 |
| $UCL_{1,95\%}$ - Land's "Exact" | 1.088 |
| **95th Percentile** | 0.758 |
| $UTL_{95\%,95\%}$ | 4.041 |
| **Percent above OEL (%>OEL)** | 26.216 |
| $LCL_{1,95\%}$ %>OEL | 11.611 |
| $UCL_{1,95\%}$ %>OEL | 48.186 |

| NORMAL PARAMETRIC STATISTICS | |
|---|---|
| **Mean** | 0.205 |
| $LCL_{1,95\%}$ - t statistics | -0.007 |
| $UCL_{1,95\%}$ - t statistics | 0.417 |
| **95th Percentile - Z** | 0.807 |
| $UTL_{95\%,95\%}$ | 1.27 |
| **Percent above OEL (%>OEL)** | 50.578 |



# APPENDIX I-4

# DMSA 400-03 Gold Dissolver

# C-400 DMSA 400-03
## Wipe and Bulk Samples from Ground Level Surfaces

| RESULTS | MATRIX | UNITS | PROJ_SAMPLE_ID | RSLTQUAL | LOCATION |
|---|---|---|---|---|---|
| 0.5 | SOLID | mg/kg | 400LAU052B | U | |
| **1.22** | **SOLID** | **mg/kg** | **400LAU053B** | | **Top of control panel in DMSA 400-03** |
| | | | | | |
| | **Minimum** | **Maximum** | | | |
| **Range** | **0.5** | **1.22** | | | |
| | | | | | |
| 0.075 | WIPE | ug/wipe | 400LAU001W | | |
| 0.075 | WIPE | ug/wipe | 400LAU001WD | | |
| 0.025 | WIPE | ug/wipe | 400LAU002W | J | |
| 0.055 | WIPE | ug/wipe | 400LAU003W | J | |
| 0.075 | WIPE | ug/wipe | 400LAU004W | | |
| **0.225** | **WIPE** | **ug/wipe** | **400LAU005W** | | **Process piping in DMSA 400-03** |
| | | | | | |
| | **Minimum** | **Maximum** | | | |
| **Range** | **0.025** | **0.225** | | | |

## Surface Wipe Sample Statistics

**Data Description:** C-400 DMSA 400-03 Ground Level

| OEL |
|---|
| 0.2 |

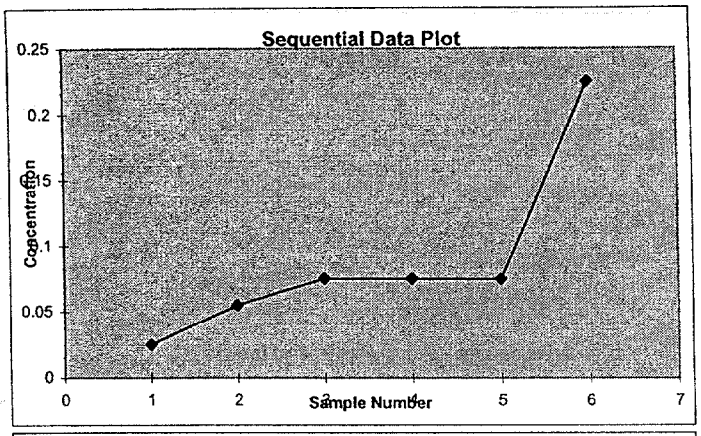
| Sample Data (max n = 50) No less than (<) or greater than (>) |
|---|
| 0.025 |
| 0.055 |
| 0.075 |
| 0.075 |
| 0.075 |
| 0.225 |

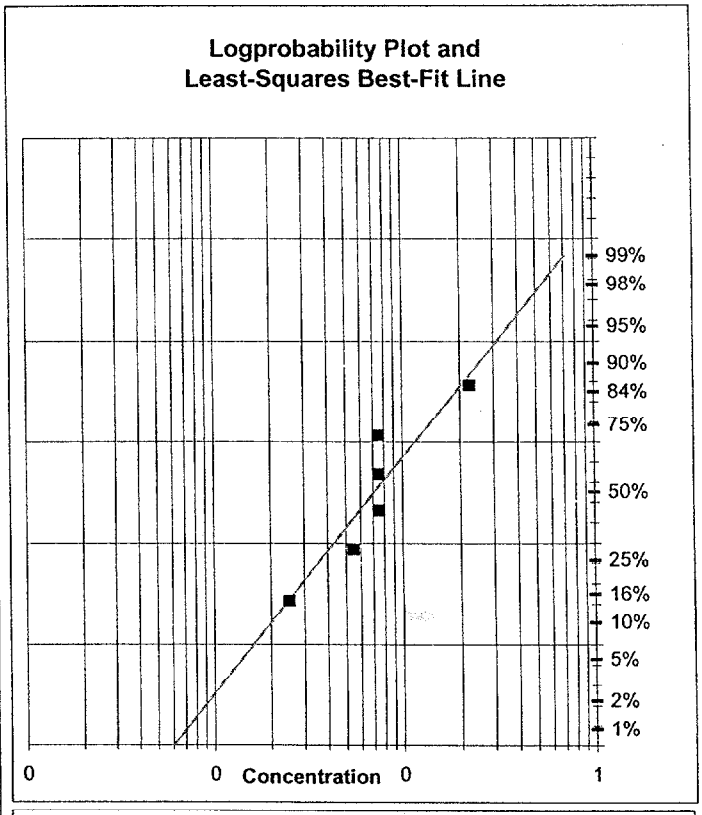
| DESCRIPTIVE STATISTICS | |
|---|---|
| Number of samples (n) | 6 |
| Maximum (max) | 0.225 |
| Minimum (min) | 0.025 |
| Range | 0.2 |
| Percent above OEL (%>OEL) | 16.667 |
| Mean | 0.088 |
| Median | 0.075 |
| Standard deviation (s) | 0.070 |
| Mean of logtransformed data (LN) | -2.642 |
| Std. deviation of logtransformed data (LN) | 0.706 |
| Geometric mean (GM) | 0.071 |
| Geometric standard deviation (GSD) | 2.026 |

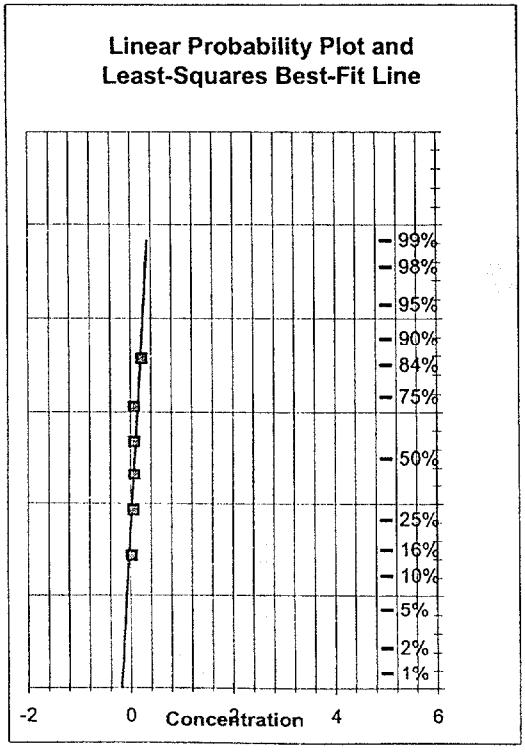
| TEST FOR DISTRIBUTION FIT | |
|---|---|
| W-test of logtransformed data (LN) | 0.906 |
| Lognormal (a = 0.05)? | Yes |
| W-test of data | 0.742 |
| Normal (a = 0.05)? | No |

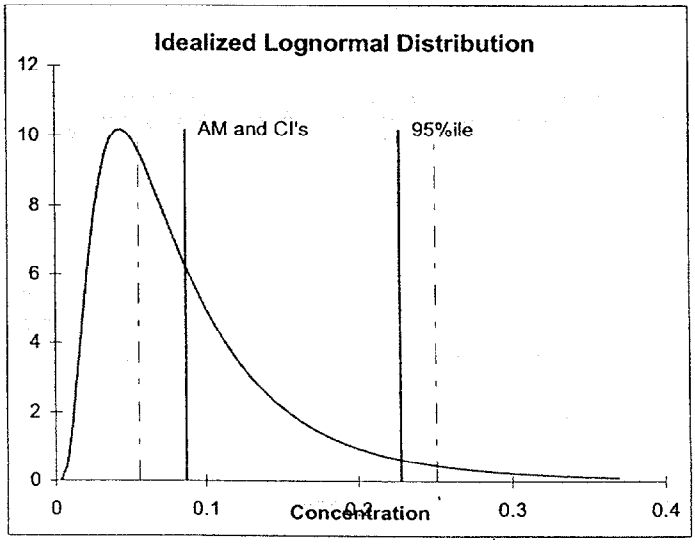
| LOGNORMAL PARAMETRIC STATISTICS | |
|---|---|
| **Estimated Arithmetic Mean - MVUE** | 0.087 |
| $LCL_{1,95\%}$ - Land's "Exact" | 0.056 |
| $UCL_{1,95\%}$ - Land's "Exact" | 0.251 |
| **95th Percentile** | 0.228 |
| $UTL_{95\%,95\%}$ | 0.976 |
| **Percent above OEL (%>OEL)** | 7.188 |
| $LCL_{1,95\%}$ %>OEL | 0.788 |
| $UCL_{1,95\%}$ %>OEL | 33.796 |

| NORMAL PARAMETRIC STATISTICS | |
|---|---|
| **Mean** | 0.088 |
| $LCL_{1,95\%}$ - t statistics | 0.031 |
| $UCL_{1,95\%}$ - t statistics | 0.146 |
| **95th Percentile - Z** | 0.203 |
| $UTL_{95\%,95\%}$ | 0.35 |
| **Percent above OEL (%>OEL)** | 5.472 |



# APPENDIX J

# DMSA 400-04 Gold Room

# C-400 Gold Room - DMSA 400-04
## All Samples

| RESULTS | MATRIX | UNITS | PROJ_SAMPLE_ID | RSLTQUAL | LOCATION |
|---|---|---|---|---|---|
| | | | **Air** | | |
| 0.01 | FILTER | ug/filter | 400GR012A | U | |
| | | | | | |
| | | | **Bulk** | | |
| **1.96** | **SOLID** | **mg/kg** | **400GR013B** | | **Miscellaneous horizontal surface** |
| 0.5 | SOLID | mg/kg | 400GR014B | U | |
| 0.5 | SOLID | mg/kg | 400GR014BD | U | |
| **1.28** | **SOLID** | **mg/kg** | **400GR015B** | | **Miscellaneous horizontal surface** |
| | | | | | |
| | **Minimum** | **Maximum** | | | |
| **Range** | **0.50** | **1.96** | | | |
| | | | | | |
| | | | **Wipe** | | |
| 0.023 | WIPE | ug/wipe | 400GR001W | J | |
| 0.123 | WIPE | ug/wipe | 400GR002W | | |
| 0.015 | WIPE | ug/wipe | 400GR002WD | U | |
| 0.015 | WIPE | ug/wipe | 400GR003W | U | |
| 0.015 | WIPE | ug/wipe | 400GR004W | U | |
| 0.015 | WIPE | ug/wipe | 400GR005W | U | |
| 0.015 | WIPE | ug/wipe | 400GR006W | U | |
| 0.023 | WIPE | ug/wipe | 400GR007W | J | |
| 0.023 | WIPE | ug/wipe | 400GR008W | J | |
| **0.695** | **WIPE** | **ug/wipe** | **400GR009W** | | **Shelf immediately inside door** |
| 0.015 | WIPE | ug/wipe | 400GR010W | U | |
| | | | | | |
| | **Minimum** | **Maximum** | | | |
| **Range** | **0.015** | **0.695** | | | |

# APPENDIX K-1

## C-720 Building Gauge Shop

# C-720 Gauge Shop
## All Samples

| RESULTS | MATRIX | UNITS | PROJ_SAMPLE_ID | RSLTQUAL | LOCATION |
|---|---|---|---|---|---|
| 0.01 | FILTER | ug/filter | 720GS045P | U | |
| 0.01 | FILTER | ug/filter | 720GS047A | U | |
| | | | | | |
| 0.5 | SOLID | mg/kg | 720GS048B | U | |
| 0.5 | SOLID | mg/kg | 720GS049B | U | |
| 0.51 | SOLID | mg/kg | 720GS050B | | |
| 0.5 | SOLID | mg/kg | 720GS050BD | U | |
| | | | | | |
| | **Minimum** | **Maximum** | | | |
| **Range** | **0.5** | **0.51** | | | |
| | | | | | |
| 0.015 | WIPE | ug/wipe | 720GS001W | U | |
| 0.015 | WIPE | ug/wipe | 720GS002W | U | |
| 0.015 | WIPE | ug/wipe | 720GS003W | U | |
| 0.015 | WIPE | ug/wipe | 720GS004W | U | |
| 0.015 | WIPE | ug/wipe | 720GS005W | U | |
| 0.015 | WIPE | ug/wipe | 720GS006W | U | |
| 0.015 | WIPE | ug/wipe | 720GS007W | U | |
| 0.015 | WIPE | ug/wipe | 720GS008W | U | |
| 0.015 | WIPE | ug/wipe | 720GS009W | U | |
| 0.015 | WIPE | ug/wipe | 720GS010W | U | |
| 0.015 | WIPE | ug/wipe | 720GS010WD | U | |
| 0.015 | WIPE | ug/wipe | 720GS011W | U | |
| 0.015 | WIPE | ug/wipe | 720GS012W | U | |
| 0.015 | WIPE | ug/wipe | 720GS013W | U | |
| 0.015 | WIPE | ug/wipe | 720GS014W | U | |
| 0.015 | WIPE | ug/wipe | 720GS015W | U | |
| 0.015 | WIPE | ug/wipe | 720GS016W | U | |
| 0.015 | WIPE | ug/wipe | 720GS017W | U | |
| 0.015 | WIPE | ug/wipe | 720GS018W | U | |
| 0.015 | WIPE | ug/wipe | 720GS019W | U | |
| 0.015 | WIPE | ug/wipe | 720GS020W | U | |
| 0.015 | WIPE | ug/wipe | 720GS021W | U | |
| 0.015 | WIPE | ug/wipe | 720GS022W | U | |
| 0.015 | WIPE | ug/wipe | 720GS023W | U | |
| 0.015 | WIPE | ug/wipe | 720GS024W | U | |
| 0.015 | WIPE | ug/wipe | 720GS025W | U | |
| 0.015 | WIPE | ug/wipe | 720GS026W | U | |
| 0.015 | WIPE | ug/wipe | 720GS027W | U | |
| 0.015 | WIPE | ug/wipe | 720GS028W | U | |
| 0.015 | WIPE | ug/wipe | 720GS029W | U | |
| 0.01 | WIPE | ug/wipe | 720GS030W | NU | |
| 0.01 | WIPE | ug/wipe | 720GS030WD | NU | |
| 0.01 | WIPE | ug/wipe | 720GS031WR | U | |
| 0.01 | WIPE | ug/wipe | 720GS032W | NU | |
| 0.15 | WIPE | ug/wipe | 720GS033W | N | |
| **0.275** | **WIPE** | **ug/wipe** | **720GS034W** | **N** | **Floor** |
| 0.01 | WIPE | ug/wipe | 720GS035WR | U | |
| 0.025 | WIPE | ug/wipe | 720GS036WR | J | |

# C-720 Gauge Shop
## All Samples

| RESULTS | MATRIX | UNITS | PROJ_SAMPLE_ID | RSLTQUAL | LOCATION |
|---|---|---|---|---|---|
| 0.01 | WIPE | ug/wipe | 720GS037WR | U | |
| 0.025 | WIPE | ug/wipe | 720GS038WR | J | |
| 0.023 | WIPE | ug/wipe | 720GS039W | J | |
| 0.025 | WIPE | ug/wipe | 720GS040W | J | |
| 0.023 | WIPE | ug/wipe | 720GS040WD | J | |
| 0.04 | WIPE | ug/wipe | 720GS041W | J | |
| 0.148 | WIPE | ug/wipe | 720MS053W | | |
| 0.023 | WIPE | ug/wipe | 720MS054W | J | |
| 0.023 | WIPE | ug/wipe | 720MS055W | J | |
| | | | | | |
| | **Minimum** | **Maximum** | | | |
| **Range** | **0.01** | **0.275** | | | |

C-720 Gauge Shop, Machine Shop and C-720-C Converter Shop
Probability Plot

SUMMARY OUTPUT

| *Regression Statistics* | |
|---|---|
| Multiple R | 0.97933428 |
| R Square | 0.95909562 |
| Adjusted R Square | 0.95872377 |
| Standard Error | 0.14605443 |
| Observations | 112 |

ANOVA

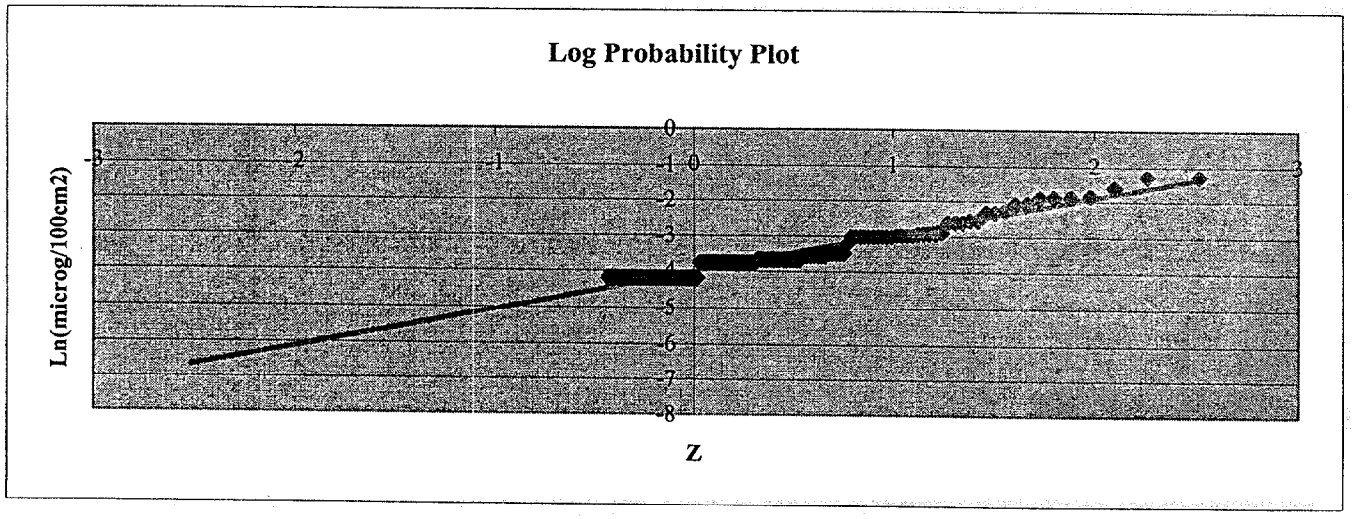
| | *df* | *SS* | *MS* | *F* | *Significance F* |
|---|---|---|---|---|---|
| Regression | 1 | 55.0192032 | 55.0192032 | 2579.19886 | 3.4395E-78 |
| Residual | 110 | 2.34650861 | 0.0213319 | | |
| Total | 111 | 57.3657118 | | | |

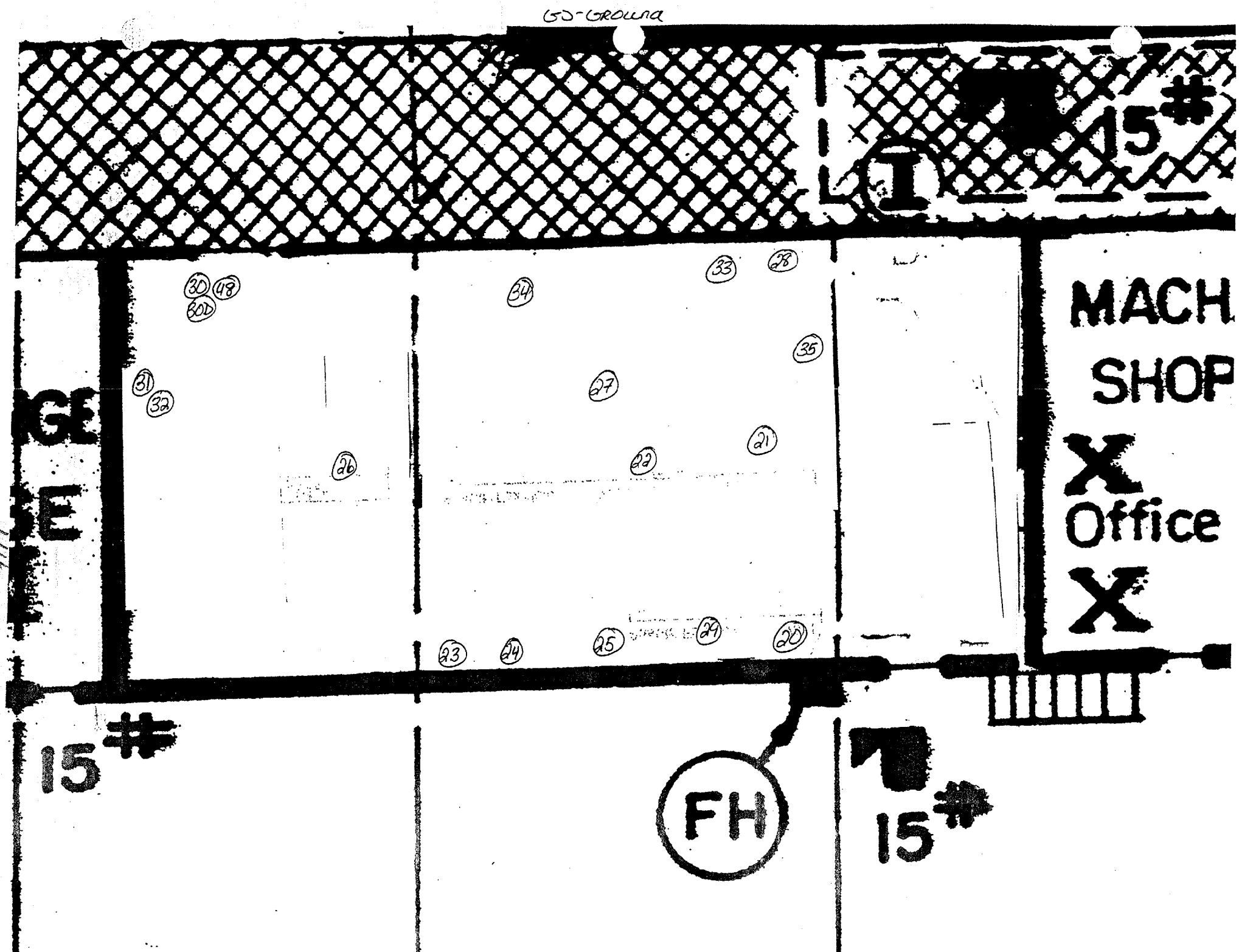
| | *Coefficients* | *Standard Error* | *t Stat* | *P-value* | *Lower 95%* | *Upper 95%* | *Lower 95.0%* | *Upper 95.0%* |
|---|---|---|---|---|---|---|---|---|
| Intercept | -4.02165597 | 0.01764221 | -227.956465 | 5.535E-149 | -4.05661871 | -3.98669323 | -4.05661871 | -3.98669323 |
| X Variable 1 | 1.05385335 | 0.02075094 | 50.7858136 | 3.4395E-78 | 1.01272984 | 1.09497686 | 1.01272984 | 1.09497686 |

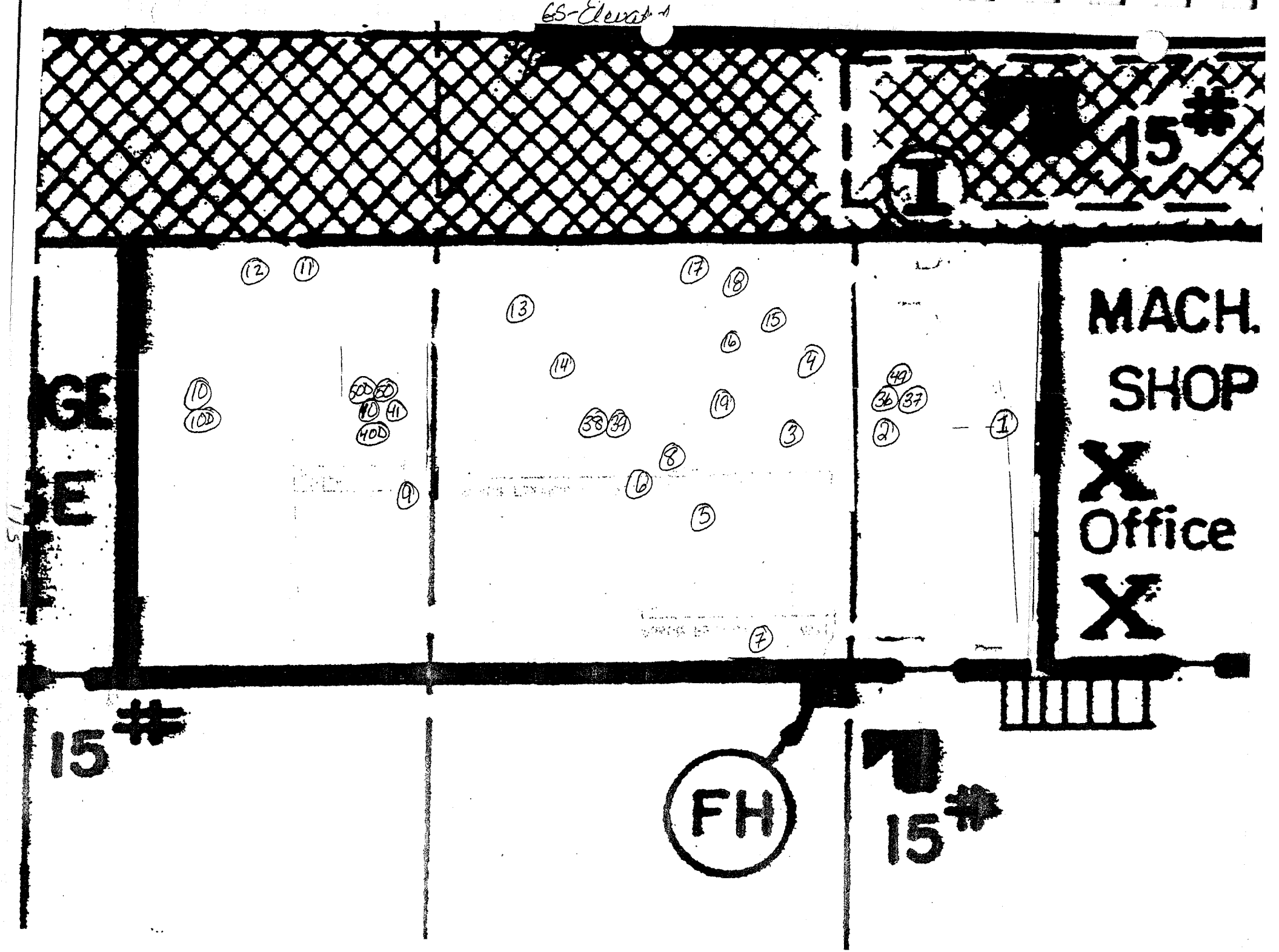
From Regression Output

| | | |
|---|---|---|
| Geometric Mean | 0.018 µg/100cm² | By EXP of Regression Intercept |
| Geometric Standard Deviation | 2.869 | By EXP of Regression Constant |
| Arithmetic Mean | 0.031 µg/100cm² | By EXP(ln GM + 1/2 (ln GSD)^2) |
| Estimated 95th Percentile | 0.101 µg/100cm² | By EXP(lnGM + 1.645*(ln GSD)) |
| Z value of OEL | 2.289 | By Z = [ln(OEL)-ln(GM)]/ln(GSD) |
| Percent less than OEL | 98.9% | By Excel NORMSDIST(Z) |
| 95/95 Geometric Upper Tolerance Limit | 0.127 µg/100cm² | By EXP(ln GM + K*(ln GSD)) |

| | | |
|---|---|---|
| a = | 0.9919 | = 1-Zg^2/(2*(n-1)) |
| b = | 2.6893 | = Zp^2-(Zg^2/n) |
| K = | 1.8552 | = (Zp+(Zp^2-(a*b))^0.5)/a |




GS-Ground
15#
1
MACH
SHOP
X
Office
X
GE
E
30
48
60D
34
33
28
35
31
32
27
21
26
22
23
24
25
29
20
15#
FH
15#


GS-Elevat
15#
MACH.
SHOP
X
Office
X
GE
E
15#
FH
15#

# APPENDIX K-2

# C-720 Building Machine Shop

# C-720 Machine Shop
## All Samples

| RESULTS | MATRIX | UNITS | PROJ_SAMPLE_ID | RSLT QUAL | AREA[1] (cm2) | CALCULATED RESULTS | LOCATION |
|---|---|---|---|---|---|---|---|
| | | | **Air** | | | | |
| 0.01 | FILTER | ug/filter | 720MS090P | U | | | |
| 0.01 | FILTER | ug/filter | 720MS092P | U | | | |
| 0.01 | FILTER | ug/filter | 720MS094A | U | | | |
| 0.01 | FILTER | ug/filter | 720MS096A | U | | | |
| 0.01 | FILTER | ug/filter | 720MS097A | U | | | |
| 0.01 | FILTER | ug/filter | 720MS120P | U | | | |
| | | | | | | | |
| | | | **Bulk** | | | | |
| 0.5 | SOLID | mg/kg | 720MS098B | U | | | |
| 0.5 | SOLID | mg/kg | 720MS099B | U | | | |
| 0.5 | SOLID | mg/kg | 720MS100B | U | | | |
| 0.5 | SOLID | mg/kg | 720MS101B | U | | | |
| 0.5 | SOLID | mg/kg | 720MS102B | U | | | |
| 0.5 | SOLID | mg/kg | 720MS103B | U | | | |
| **0.653** | **SOLID** | **mg/kg** | **720MS104B** | | | | **Floor at Verson Press** |
| 0.5 | SOLID | mg/kg | 720MS105B | U | | | |
| 0.5 | SOLID | mg/kg | 720MS106B | U | | | |
| 0.5 | SOLID | mg/kg | 720MS107B | U | | | |
| 0.5 | SOLID | mg/kg | 720MS108B | U | | | |
| 0.5 | SOLID | mg/kg | 720MS109B | U | | | |
| 0.5 | SOLID | mg/kg | 720MS109BD | U | | | |
| | | | | | | | |
| | **Minimum** | **Maximum** | | | | | |
| **Range** | **0.5** | **0.653** | | | | | |
| | | | | | | | |
| | | | **Wipe** | | | | |
| 0.048 | WIPE | ug/wipe | 720MS001W | J | | | |
| 0.048 | WIPE | ug/wipe | 720MS002W | J | | | |
| 0.048 | WIPE | ug/wipe | 720MS003W | J | | | |
| 0.023 | WIPE | ug/wipe | 720MS004W | J | | | |
| 0.023 | WIPE | ug/wipe | 720MS005W | J | | | |
| 0.073 | WIPE | ug/wipe | 720MS006W | J | | | |
| 0.048 | WIPE | ug/wipe | 720MS007W | J | | | |
| 0.023 | WIPE | ug/wipe | 720MS008W | J | | | |
| 0.048 | WIPE | ug/wipe | 720MS009W | J | | | |
| **0.273** | **WIPE** | **ug/wipe** | **720MS010W** | | | | **Top of 480 volt cabinet between F-12 and F-13** |
| 0.198 | WIPE | ug/wipe | 720MS010WD | | | | |
| 0.073 | WIPE | ug/wipe | 720MS011W | J | | | |
| 0.048 | WIPE | ug/wipe | 720MS012W | J | | | |
| 0.048 | WIPE | ug/wipe | 720MS013W | J | | | |
| 0.023 | WIPE | ug/wipe | 720MS014W | J | | | |
| 0.048 | WIPE | ug/wipe | 720MS015W | J | | | |

1. Surface wipe sample areas were 100 $cm^2$ unless otherwise noted in this column

# C-720 Machine Shop
## All Samples

| RESULTS | MATRIX | UNITS | PROJ_SAMPLE_ID | RSLT QUAL | AREA[1] (cm2) | CALCULATED RESULTS | LOCATION |
|---|---|---|---|---|---|---|---|
| 0.01 | WIPE | ug/wipe | 720MS016W | U | | | |
| 0.01 | WIPE | ug/wipe | 720MS017W | J | | | |
| 0.023 | WIPE | ug/wipe | 720MS018W | J | | | |
| 0.023 | WIPE | ug/wipe | 720MS019W | J | | | |
| 0.048 | WIPE | ug/wipe | 720MS020W | J | | | |
| 0.148 | WIPE | ug/wipe | 720MS020WD | | | | |
| 0.15 | WIPE | ug/wipe | 720MS021W | | | | |
| 0.025 | WIPE | ug/wipe | 720MS022W | J | | | |
| 0.025 | WIPE | ug/wipe | 720MS023W | J | | | |
| 0.025 | WIPE | ug/wipe | 720MS024W | J | | | |
| 0.01 | WIPE | ug/wipe | 720MS025W | U | | | |
| 0.125 | WIPE | ug/wipe | 720MS026W | | | | |
| 0.023 | WIPE | ug/wipe | 720MS027W | J | | | |
| 0.098 | WIPE | ug/wipe | 720MS028W | | | | |
| 0.123 | WIPE | ug/wipe | 720MS029W | | | | |
| 0.028 | WIPE | ug/wipe | 720MS030W | J | | | |
| 0.028 | WIPE | ug/wipe | 720MS030WD | J | | | |
| 0.103 | WIPE | ug/wipe | 720MS031W | | | | |
| 0.028 | WIPE | ug/wipe | 720MS032W | J | | | |
| 0.078 | WIPE | ug/wipe | 720MS033W | | | | |
| 0.053 | WIPE | ug/wipe | 720MS034W | J | | | |
| 0.053 | WIPE | ug/wipe | 720MS035W | J | | | |
| 0.053 | WIPE | ug/wipe | 720MS036W | J | | | |
| 0.053 | WIPE | ug/wipe | 720MS037W | J | | | |
| 0.078 | WIPE | ug/wipe | 720MS038W | | | | |
| 0.155 | WIPE | ug/wipe | 720MS039W | | | | |
| 0.023 | WIPE | ug/wipe | 720MS040W | J | | | |
| 0.023 | WIPE | ug/wipe | 720MS040WD | J | | | |
| 0.01 | WIPE | ug/wipe | 720MS041W | U | | | |
| 0.025 | WIPE | ug/wipe | 720MS042W | J | | | |
| 0.01 | WIPE | ug/wipe | 720MS043W | U | | | |
| 0.01 | WIPE | ug/wipe | 720MS044W | U | | | |
| 0.025 | WIPE | ug/wipe | 720MS045W | J | | | |
| 0.01 | WIPE | ug/wipe | 720MS046W | U | | | |
| 0.01 | WIPE | ug/wipe | 720MS047W | U | | | |
| 0.01 | WIPE | ug/wipe | 720MS048W | U | | | |
| 0.01 | WIPE | ug/wipe | 720MS049W | U | | | |
| 0.05 | WIPE | ug/wipe | 720MS050W | J | | | |
| 0.01 | WIPE | ug/wipe | 720MS051W | U | | | |
| 0.01 | WIPE | ug/wipe | 720MS052W | U | | | |
| 0.01 | WIPE | ug/wipe | 720MS056W | U | | | |
| 0.01 | WIPE | ug/wipe | 720MS057W | U | | | |
| 0.01 | WIPE | ug/wipe | 720MS058W | U | | | |
| 0.01 | WIPE | ug/wipe | 720MS059W | U | | | |
| 0.023 | WIPE | ug/wipe | 720MS060W | J | | | |
| 0.01 | WIPE | ug/wipe | 720MS061W | U | | | |
| 0.01 | WIPE | ug/wipe | 720MS062W | U | | | |
| 0.01 | WIPE | ug/wipe | 720MS063W | U | | | |

1. Surface wipe sample areas were 100 $cm^2$ unless otherwise noted in this column

# C-720 Machine Shop
## All Samples

| RESULTS | MATRIX | UNITS | PROJ_SAMPLE_ID | RSLT QUAL | AREA[1] (cm2) | CALCULATED RESULTS | LOCATION |
|---|---|---|---|---|---|---|---|
| 0.01 | WIPE | ug/wipe | 720MS064W | U | | | |
| 0.01 | WIPE | ug/wipe | 720MS065W | U | | | |
| 0.01 | WIPE | ug/wipe | 720MS066W | U | | | |
| 0.01 | WIPE | ug/wipe | 720MS067W | U | | | |
| 0.01 | WIPE | ug/wipe | 720MS068W | U | | | |
| 0.023 | WIPE | ug/wipe | 720MS069W | J | | | |
| 0.01 | WIPE | ug/wipe | 720MS070W | U | | | |
| 0.023 | WIPE | ug/wipe | 720MS070WD | J | | | |
| 0.023 | WIPE | ug/wipe | 720MS071W | JN | | | |
| 0.023 | WIPE | ug/wipe | 720MS072W | JN | | | |
| 0.098 | WIPE | ug/wipe | 720MS073W | N | | | |
| 0.01 | WIPE | ug/wipe | 720MS074W | NU | | | |
| 0.01 | WIPE | ug/wipe | 720MS075W | NU | | | |
| 0.01 | WIPE | ug/wipe | 720MS076W | NU | | | |
| 0.01 | WIPE | ug/wipe | 720MS077W | NU | | | |
| 0.023 | WIPE | ug/wipe | 720MS078W | JN | | | |
| 0.01 | WIPE | ug/wipe | 720MS079W | NU | | | |
| 0.01 | WIPE | ug/wipe | 720MS080W | NU | | | |
| 0.023 | WIPE | ug/wipe | 720MS081W | J | | | |
| 0.048 | WIPE | ug/wipe | 720MS082W | J | | | |
| 0.023 | WIPE | ug/wipe | 720MS083W | J | | | |
| 0.073 | WIPE | ug/wipe | 720MS084W | J | | | |
| | | | | | | | |
| 0.025 | WIPE | ug/wipe | 720MS110W | J | | | |
| **0.1** | **WIPE** | **ug/wipe** | **720MS111W** | | **10** | **1** | **Roof - exhaust fan 720-002** |
| **0.125** | **WIPE** | **ug/wipe** | **720MS112W** | | **10** | **1.25** | **Roof - exhaust fan 720-002** |
| **0.175** | **WIPE** | **ug/wipe** | **720MS113W** | | **50** | **0.35** | **Roof - exhaust fan 720-061** |
| **0.525** | **WIPE** | **ug/wipe** | **720MS114W** | | | | **Roof - exhaust fan 720-061** |
| **0.25** | **WIPE** | **ug/wipe** | **720MS116W** | | | | **Roof - exhaust fan 720-061** |
| 0.08 | WIPE | ug/wipe | 720MS117W | | 50 | 0.16 | |
| 0.03 | WIPE | ug/wipe | 720MS118W | J | | | |
| **0.13** | **WIPE** | **ug/wipe** | **720MS119W** | | **50** | **0.26** | **Roof - exhaust fan 720-059** |
| | | | | | | | |
| | **Minimum** | **Maximum** | | | | | |
| **Range** | **0.01** | **1.25** | | | | | |

1. Surface wipe sample areas were 100 $cm^2$ unless otherwise noted in this column

# APPENDIX K-3

## C-720 Building Machine Shop Elevated Surfaces

# C-720 Machine Shop
## Wipe and Bulk Samples from Elevated Surfaces

| RESULTS | MATRIX | UNITS | PROJ_SAMPLE_ID | RSLT QUAL |
|---|---|---|---|---|
| **Bulk** | | | | |
| 0.5 | SOLID | mg/kg | 720MS101B | U |
| 0.5 | SOLID | mg/kg | 720MS102B | U |
| 0.5 | SOLID | mg/kg | 720MS103B | U |
| | | | | |
| | **Minimum** | **Maximum** | | |
| **Range** | **0.5** | **0.5** | | |
| | | | | |
| **Wipe** | | | | |
| 0.048 | WIPE | ug/wipe | 720MS020W | J |
| 0.148 | WIPE | ug/wipe | 720MS020WD | |
| 0.15 | WIPE | ug/wipe | 720MS021W | |
| 0.025 | WIPE | ug/wipe | 720MS022W | J |
| 0.025 | WIPE | ug/wipe | 720MS023W | J |
| 0.025 | WIPE | ug/wipe | 720MS024W | J |
| 0.01 | WIPE | ug/wipe | 720MS025W | U |
| 0.125 | WIPE | ug/wipe | 720MS026W | |
| 0.023 | WIPE | ug/wipe | 720MS027W | J |
| 0.098 | WIPE | ug/wipe | 720MS028W | |
| 0.123 | WIPE | ug/wipe | 720MS029W | |
| 0.028 | WIPE | ug/wipe | 720MS030W | J |
| 0.028 | WIPE | ug/wipe | 720MS030WD | J |
| 0.103 | WIPE | ug/wipe | 720MS031W | |
| 0.028 | WIPE | ug/wipe | 720MS032W | J |
| 0.078 | WIPE | ug/wipe | 720MS033W | |
| 0.053 | WIPE | ug/wipe | 720MS034W | J |
| 0.053 | WIPE | ug/wipe | 720MS035W | J |
| 0.053 | WIPE | ug/wipe | 720MS036W | J |
| 0.053 | WIPE | ug/wipe | 720MS037W | J |
| 0.078 | WIPE | ug/wipe | 720MS038W | |
| 0.155 | WIPE | ug/wipe | 720MS039W | |
| | | | | |
| | **Minimum** | **Maximum** | | |
| **Range** | **0.01** | **0.155** | | |

# APPENDIX K-4

## C-720 Building Machine Shop Ground Level Surfaces

# C-720 Machine Shop
## Wipe and Bulk Samples from Ground Level Surfaces

| RESULTS | MATRIX | UNITS | PROJ_SAMPLE_ID | RSLT QUAL | LOCATION |
|---|---|---|---|---|---|
| | | | **Bulk** | | |
| 0.5 | SOLID | mg/kg | 720MS098B | U | |
| 0.5 | SOLID | mg/kg | 720MS099B | U | |
| 0.5 | SOLID | mg/kg | 720MS100B | U | |
| | | | | | |
| | **Minimum** | **Maximum** | | | |
| **Range** | **0.5** | **0.5** | | | |
| | | | | | |
| | | | **Wipe** | | |
| 0.048 | WIPE | ug/wipe | 720MS001W | J | |
| 0.048 | WIPE | ug/wipe | 720MS002W | J | |
| 0.048 | WIPE | ug/wipe | 720MS003W | J | |
| 0.023 | WIPE | ug/wipe | 720MS004W | J | |
| 0.023 | WIPE | ug/wipe | 720MS005W | J | |
| 0.073 | WIPE | ug/wipe | 720MS006W | J | |
| 0.048 | WIPE | ug/wipe | 720MS007W | J | |
| 0.023 | WIPE | ug/wipe | 720MS008W | J | |
| 0.048 | WIPE | ug/wipe | 720MS009W | J | |
| **0.273** | **WIPE** | **ug/wipe** | **720MS010W** | | **Top of 480 volt cabinet between F-12 and F-13** |
| 0.198 | WIPE | ug/wipe | 720MS010WD | | |
| 0.073 | WIPE | ug/wipe | 720MS011W | J | |
| 0.048 | WIPE | ug/wipe | 720MS012W | J | |
| 0.048 | WIPE | ug/wipe | 720MS013W | J | |
| 0.023 | WIPE | ug/wipe | 720MS014W | J | |
| 0.048 | WIPE | ug/wipe | 720MS015W | J | |
| 0.01 | WIPE | ug/wipe | 720MS016W | U | |
| 0.01 | WIPE | ug/wipe | 720MS017W | J | |
| 0.023 | WIPE | ug/wipe | 720MS018W | J | |
| 0.023 | WIPE | ug/wipe | 720MS019W | J | |
| | | | | | |
| | **Minimum** | **Maximum** | | | |
| **Range** | **0.01** | **0.273** | | | |

# APPENDIX K-5

## C-720 Building Machine Shop Machines

# C-720 Machine Shop
## Wipe and Bulk Samples from Machines

| RESULTS | MATRIX | UNITS | PROJ_SAMPLE_ID | RSLT QUAL | LOCATION |
|---|---|---|---|---|---|
| | | | **Bulk** | | |
| **0.653** | **SOLID** | **mg/kg** | **720MS104B** | | **Floor at Verson Press** |
| 0.5 | SOLID | mg/kg | 720MS105B | U | |
| 0.5 | SOLID | mg/kg | 720MS106B | U | |
| 0.5 | SOLID | mg/kg | 720MS107B | U | |
| 0.5 | SOLID | mg/kg | 720MS108B | U | |
| 0.5 | SOLID | mg/kg | 720MS109B | U | |
| 0.5 | SOLID | mg/kg | 720MS109BD | U | |
| | | | | | |
| | **Minimum** | **Maximum** | | | |
| **Range** | **0.5** | **0.653** | | | |
| | | | | | |
| | | | **Wipe** | | |
| 0.023 | WIPE | ug/wipe | 720MS040W | J | |
| 0.023 | WIPE | ug/wipe | 720MS040WD | J | |
| 0.01 | WIPE | ug/wipe | 720MS041W | U | |
| 0.025 | WIPE | ug/wipe | 720MS042W | J | |
| 0.01 | WIPE | ug/wipe | 720MS043W | U | |
| 0.01 | WIPE | ug/wipe | 720MS044W | U | |
| 0.025 | WIPE | ug/wipe | 720MS045W | J | |
| 0.01 | WIPE | ug/wipe | 720MS046W | U | |
| 0.01 | WIPE | ug/wipe | 720MS047W | U | |
| 0.01 | WIPE | ug/wipe | 720MS048W | U | |
| 0.01 | WIPE | ug/wipe | 720MS049W | U | |
| 0.05 | WIPE | ug/wipe | 720MS050W | J | |
| 0.01 | WIPE | ug/wipe | 720MS051W | U | |
| 0.01 | WIPE | ug/wipe | 720MS052W | U | |
| 0.01 | WIPE | ug/wipe | 720MS056W | U | |
| 0.01 | WIPE | ug/wipe | 720MS057W | U | |
| 0.01 | WIPE | ug/wipe | 720MS058W | U | |
| 0.01 | WIPE | ug/wipe | 720MS059W | U | |
| 0.023 | WIPE | ug/wipe | 720MS060W | J | |
| 0.01 | WIPE | ug/wipe | 720MS061W | U | |
| 0.01 | WIPE | ug/wipe | 720MS062W | U | |
| 0.01 | WIPE | ug/wipe | 720MS063W | U | |
| 0.01 | WIPE | ug/wipe | 720MS064W | U | |
| 0.01 | WIPE | ug/wipe | 720MS065W | U | |
| 0.01 | WIPE | ug/wipe | 720MS066W | U | |
| 0.01 | WIPE | ug/wipe | 720MS067W | U | |
| 0.01 | WIPE | ug/wipe | 720MS068W | U | |
| 0.023 | WIPE | ug/wipe | 720MS069W | J | |
| 0.01 | WIPE | ug/wipe | 720MS070W | U | |
| 0.023 | WIPE | ug/wipe | 720MS070WD | J | |
| 0.023 | WIPE | ug/wipe | 720MS071W | JN | |
| 0.023 | WIPE | ug/wipe | 720MS072W | JN | |
| 0.098 | WIPE | ug/wipe | 720MS073W | N | |
| 0.01 | WIPE | ug/wipe | 720MS074W | NU | |
| 0.01 | WIPE | ug/wipe | 720MS075W | NU | |

# C-720 Machine Shop
## Wipe and Bulk Samples from Machines

| RESULTS | MATRIX | UNITS | PROJ_SAMPLE_ID | RSLT QUAL | LOCATION |
|---|---|---|---|---|---|
| 0.01 | WIPE | ug/wipe | 720MS076W | NU | |
| 0.01 | WIPE | ug/wipe | 720MS077W | NU | |
| 0.023 | WIPE | ug/wipe | 720MS078W | JN | |
| 0.01 | WIPE | ug/wipe | 720MS079W | NU | |
| 0.01 | WIPE | ug/wipe | 720MS080W | NU | |
| 0.023 | WIPE | ug/wipe | 720MS081W | J | |
| 0.048 | WIPE | ug/wipe | 720MS082W | J | |
| 0.023 | WIPE | ug/wipe | 720MS083W | J | |
| 0.073 | WIPE | ug/wipe | 720MS084W | J | |
| | | | | | |
| | **Minimum** | **Maximum** | | | |
| **Range** | **0.01** | **0.098** | | | |

# APPENDIX K-6

## C-720 -C Building – Converter Shop

# C-720-C Converter Shop
## All Samples

| RESULTS | MATRIX | UNITS | PROJ_SAMPLE_ID | RSLTQUAL |
|---|---|---|---|---|
| 0.01 | FILTER | ug/filter | 720CS038P | U |
| 0.01 | FILTER | ug/filter | 720CS041A | U |
| 0.01 | FILTER | ug/filter | 720CS042A | U |
| | | | | |
| 0.5 | SOLID | mg/kg | 720CS044B | U |
| 0.5 | SOLID | mg/kg | 720CS044BD | U |
| 0.5 | SOLID | mg/kg | 720CS045B | U |
| 0.5 | SOLID | mg/kg | 720CS046B | U |
| | | | | |
| | **Minimum** | **Maximum** | | |
| **Range** | **0.5** | **0.5** | | |
| | | | | |
| 0.01 | WIPE | ug/wipe | 720CS001W | U |
| 0.01 | WIPE | ug/wipe | 720CS002W | U |
| 0.03 | WIPE | ug/wipe | 720CS003W | J |
| 0.01 | WIPE | ug/wipe | 720CS004W | U |
| 0.01 | WIPE | ug/wipe | 720CS005W | U |
| 0.03 | WIPE | ug/wipe | 720CS006W | J |
| 0.01 | WIPE | ug/wipe | 720CS007W | U |
| 0.01 | WIPE | ug/wipe | 720CS008W | U |
| 0.03 | WIPE | ug/wipe | 720CS009W | J |
| 0.028 | WIPE | ug/wipe | 720CS010W | J |
| 0.01 | WIPE | ug/wipe | 720CS011W | U |
| 0.01 | WIPE | ug/wipe | 720CS012W | U |
| 0.01 | WIPE | ug/wipe | 720CS012WD | U |
| 0.028 | WIPE | ug/wipe | 720CS013W | J |
| 0.01 | WIPE | ug/wipe | 720CS014W | U |
| 0.01 | WIPE | ug/wipe | 720CS015W | U |
| 0.028 | WIPE | ug/wipe | 720CS016W | J |
| 0.028 | WIPE | ug/wipe | 720CS017W | J |
| 0.01 | WIPE | ug/wipe | 720CS018W | U |
| 0.05 | WIPE | ug/wipe | 720CS019W | J |
| 0.01 | WIPE | ug/wipe | 720CS020W | U |
| 0.025 | WIPE | ug/wipe | 720CS021W | J |
| 0.025 | WIPE | ug/wipe | 720CS022W | J |
| 0.05 | WIPE | ug/wipe | 720CS023W | J |
| 0.025 | WIPE | ug/wipe | 720CS024W | J |
| 0.025 | WIPE | ug/wipe | 720CS025W | J |
| 0.05 | WIPE | ug/wipe | 720CS026W | J |
| 0.025 | WIPE | ug/wipe | 720CS027W | J |
| 0.025 | WIPE | ug/wipe | 720CS028W | J |
| 0.01 | WIPE | ug/wipe | 720CS029W | U |
| 0.01 | WIPE | ug/wipe | 720CS030W | U |
| 0.01 | WIPE | ug/wipe | 720CS030WD | U |
| 0.01 | WIPE | ug/wipe | 720CS031W | U |
| 0.01 | WIPE | ug/wipe | 720CS032W | U |
| 0.055 | WIPE | ug/wipe | 720CS033W | J |
| 0.03 | WIPE | ug/wipe | 720CS034W | J |
| 0.03 | WIPE | ug/wipe | 720CS035W | J |
| | | | | |

# C-720-C Converter Shop
## All Samples

| RESULTS | MATRIX | UNITS | PROJ_SAMPLE_ID | RSLTQUAL |
|---|---|---|---|---|
| | | | | |
| | Minimum | Maximum | | |
| Range | 0.01 | 0.055 | | |

# APPENDIX K-7

# C-720 Building – Gauge Shop CNC Mill

# C-720 Gauge Shop
# Wipe Samples from CNC Mill

| RESULTS | MATRIX | UNITS | PROJ_SAMPLE_ID | RSLTQUAL |
|---|---|---|---|---|
| | | **Wipe** | | |
| 0.148 | WIPE | ug/wipe | 720MS053W | |
| 0.023 | WIPE | ug/wipe | 720MS054W | J |
| 0.023 | WIPE | ug/wipe | 720MS055W | J |
| | | | | |
| | **Minimum** | **Maximum** | | |
| **Range** | **0.023** | **0.148** | | |

# APPENDIX K-8

# C-720 Building – Machine Shop Exhaust Ventilation

# C-720 Machine Shop
## Wipe Samples from Exhaust Ventilation

| RESULTS | MATRIX | UNITS | PROJ_SAMPLE_ID | RSLT QUAL | AREA (cm2) | CALCULATED RESULTS | LOCATION |
|---|---|---|---|---|---|---|---|
| 0.025 | WIPE | ug/wipe | 720MS110W | J | | | |
| 0.1 | WIPE | ug/wipe | 720MS111W | | 10 | 1 | Roof - exhaust fan 720-002 |
| 0.125 | WIPE | ug/wipe | 720MS112W | | 10 | 1.25 | Roof - exhaust fan 720-002 |
| 0.175 | WIPE | ug/wipe | 720MS113W | | 50 | 0.35 | Roof - exhaust fan 720-061 |
| 0.525 | WIPE | ug/wipe | 720MS114W | | | | Roof - exhaust fan 720-061 |
| 0.25 | WIPE | ug/wipe | 720MS116W | | | | Roof - exhaust fan 720-061 |
| 0.08 | WIPE | ug/wipe | 720MS117W | | 50 | 0.16 | |
| 0.03 | WIPE | ug/wipe | 720MS118W | J | | | |
| 0.13 | WIPE | ug/wipe | 720MS119W | | 50 | 0.26 | Roof - exhaust fan 720-059 |
| | | | | | | | |
| | Minimum | Maximum | | | | | |
| Range | 0.025 | 1.25 | | | | | |

1. Surface wipe sample areas were 100 $cm^2$ unless otherwise noted in this column

# APPENDIX L-1

## C-746 -A Building East Smelter

# C-746-A East Smelter
## All Samples

| RESULTS | MATRIX | UNITS | PROJ_SAMPLE_ID | RSLTQUAL | LOCATION |
|---|---|---|---|---|---|
| | | | **Air** | | |
| 0.01 | FILTER | ug/filter | 746AES133P | U | |
| 0.01 | FILTER | ug/filter | 746AES134P | U | |
| 0.01 | FILTER | ug/filter | 746AES136A | U | |
| 0.01 | FILTER | ug/filter | 746AES137A | U | |
| 0.01 | FILTER | ug/filter | 746AES138A | U | |
| | | | | | |
| | | | **Bulk** | | |
| 0.5 | SOLID | mg/kg | 746AES139B | U | |
| **0.744** | **SOLID** | **mg/kg** | **746AES140B** | | **Floor of mezzanine** |
| 0.5 | SOLID | mg/kg | 746AES141B | U | |
| 0.5 | SOLID | mg/kg | 746AES142B | U | |
| 0.5 | SOLID | mg/kg | 746AES143B | U | |
| 0.5 | SOLID | mg/kg | 746AES144B | U | |
| 0.5 | SOLID | mg/kg | 746AES145B | U | |
| 0.5 | SOLID | mg/kg | 746AES145BD | U | |
| 0.5 | SOLID | mg/kg | 746AES146B | U | |
| **0.685** | **SOLID** | **mg/kg** | **746AES147B** | | **Surface of mold** |
| **1.17** | **SOLID** | **mg/kg** | **746AES148B** | | **Miscellaneous elevated surface** |
| 0.5 | SOLID | mg/kg | 746AES149B | U | |
| **1.76** | **SOLID** | **mg/kg** | **746AES150B** | | **Miscellaneous elevated surface** |
| | | | | | |
| | **Minimum** | **Maximum** | | | |
| **Range** | **0.5** | **1.76** | | | |
| | | | | | |
| | | | **Wipe** | | |
| 0.1 | WIPE | ug/wipe | 746AES001W | | |
| 0.15 | WIPE | ug/wipe | 746AES002W | | |
| 0.125 | WIPE | ug/wipe | 746AES003W | | |
| 0.125 | WIPE | ug/wipe | 746AES004W | | |
| 0.025 | WIPE | ug/wipe | 746AES005W | J | |
| 0.075 | WIPE | ug/wipe | 746AES006W | | |
| 0.15 | WIPE | ug/wipe | 746AES007W | | |
| 0.05 | WIPE | ug/wipe | 746AES008W | J | |
| 0.025 | WIPE | ug/wipe | 746AES009W | J | |
| 0.05 | WIPE | ug/wipe | 746AES010W | J | |
| 0.04 | WIPE | ug/wipe | 746AES010WD | J | |
| 0.015 | WIPE | ug/wipe | 746AES011W | J | |
| **0.29** | **WIPE** | **ug/wipe** | **746AES012W** | | **Miscellaneous elevated surface** |
| 0.04 | WIPE | ug/wipe | 746AES013W | J | |
| 0.04 | WIPE | ug/wipe | 746AES014W | J | |
| **1.14** | **WIPE** | **ug/wipe** | **746AES015W** | | **Elevated surface - dust collector** |
| **0.84** | **WIPE** | **ug/wipe** | **746AES016W** | | **Elevated surface - duct** |
| 0.015 | WIPE | ug/wipe | 746AES017W | J | |
| 0.015 | WIPE | ug/wipe | 746AES018W | J | |
| 0.165 | WIPE | ug/wipe | 746AES019W | | |
| 0.145 | WIPE | ug/wipe | 746AES020W | | |
| 0.095 | WIPE | ug/wipe | 746AES020WD | | |

# C-746-A East Smelter
## All Samples

| RESULTS | MATRIX | UNITS | PROJ_SAMPLE_ID | RSLTQUAL | LOCATION |
|---|---|---|---|---|---|
| **0.495** | **WIPE** | **ug/wipe** | **746AES021W** | | **Miscellaneous elevated surface** |
| **0.395** | **WIPE** | **ug/wipe** | **746AES022W** | | **Miscellaneous elevated surface** |
| 0.07 | WIPE | ug/wipe | 746AES023W | J | |
| **0.27** | **WIPE** | **ug/wipe** | **746AES024W** | | **Miscellaneous elevated surface** |
| **0.395** | **WIPE** | **ug/wipe** | **746AES025W** | | **Miscellaneous elevated surface** |
| 0.145 | WIPE | ug/wipe | 746AES026W | | |
| **0.345** | **WIPE** | **ug/wipe** | **746AES027W** | | **Miscellaneous elevated surface** |
| 0.045 | WIPE | ug/wipe | 746AES028W | J | |
| **0.42** | **WIPE** | **ug/wipe** | **746AES029W** | | **Miscellaneous elevated surface** |
| 0.145 | WIPE | ug/wipe | 746AES030W | | |
| 0.143 | WIPE | ug/wipe | 746AES030WD | | |
| 0.118 | WIPE | ug/wipe | 746AES031W | | |
| 0.068 | WIPE | ug/wipe | 746AES032W | J | |
| 0.068 | WIPE | ug/wipe | 746AES033W | J | |
| 0.068 | WIPE | ug/wipe | 746AES034W | J | |
| 0.018 | WIPE | ug/wipe | 746AES035W | J | |
| 0.043 | WIPE | ug/wipe | 746AES036W | J | |
| 0.018 | WIPE | ug/wipe | 746AES037W | J | |
| 0.01 | WIPE | ug/wipe | 746AES038W | U | |
| 0.01 | WIPE | ug/wipe | 746AES039W | U | |
| 0.02 | WIPE | ug/wipe | 746AES040W | J | |
| 0.02 | WIPE | ug/wipe | 746AES040WD | J | |
| 0.01 | WIPE | ug/wipe | 746AES041WR | U | |
| 0.01 | WIPE | ug/wipe | 746AES042W | U | |
| 0.01 | WIPE | ug/wipe | 746AES043W | U | |
| 0.045 | WIPE | ug/wipe | 746AES044W | J | |
| 0.045 | WIPE | ug/wipe | 746AES045W | J | |
| 0.02 | WIPE | ug/wipe | 746AES046W | J | |
| 0.02 | WIPE | ug/wipe | 746AES047W | J | |
| 0.095 | WIPE | ug/wipe | 746AES048W | | |
| 0.07 | WIPE | ug/wipe | 746AES049W | J | |
| 0.095 | WIPE | ug/wipe | 746AES050W | | |
| 0.07 | WIPE | ug/wipe | 746AES050WD | J | |
| 0.145 | WIPE | ug/wipe | 746AES051W | | |
| 0.045 | WIPE | ug/wipe | 746AES052W | J | |
| 0.07 | WIPE | ug/wipe | 746AES053W | J | |
| 0.07 | WIPE | ug/wipe | 746AES054W | J | |
| 0.045 | WIPE | ug/wipe | 746AES055W | J | |
| 0.01 | WIPE | ug/wipe | 746AES056W | U | |
| 0.05 | WIPE | ug/wipe | 746AES057W | J | |
| 0.025 | WIPE | ug/wipe | 746AES058W | J | |
| 0.025 | WIPE | ug/wipe | 746AES059W | J | |
| 0.05 | WIPE | ug/wipe | 746AES060W | J | |
| 0.075 | WIPE | ug/wipe | 746AES060WD | | |
| 0.05 | WIPE | ug/wipe | 746AES061W | J | |
| 0.15 | WIPE | ug/wipe | 746AES062W | | |
| 0.025 | WIPE | ug/wipe | 746AES063W | J | |
| 0.01 | WIPE | ug/wipe | 746AES064WR | U | |
| 0.145 | WIPE | ug/wipe | 746AES065W | N | |
| 0.07 | WIPE | ug/wipe | 746AES066W | JN | |

# C-746-A East Smelter
## All Samples

| RESULTS | MATRIX | UNITS | PROJ_SAMPLE_ID | RSLTQUAL | LOCATION |
|---|---|---|---|---|---|
| 0.02 | WIPE | ug/wipe | 746AES067W | JN | |
| 0.02 | WIPE | ug/wipe | 746AES068W | JN | |
| 0.02 | WIPE | ug/wipe | 746AES069W | JN | |
| 0.045 | WIPE | ug/wipe | 746AES070W | JN | |
| 0.1 | WIPE | ug/wipe | 746AES071WR | | |
| 0.045 | WIPE | ug/wipe | 746AES072W | JN | |
| 0.045 | WIPE | ug/wipe | 746AES073W | JN | |
| 0.07 | WIPE | ug/wipe | 746AES074W | JN | |
| 0.025 | WIPE | ug/wipe | 746AES075W | J | |
| 0.05 | WIPE | ug/wipe | 746AES076W | J | |
| 0.075 | WIPE | ug/wipe | 746AES077W | | |
| 0.1 | WIPE | ug/wipe | 746AES078W | | |
| 0.05 | WIPE | ug/wipe | 746AES079W | J | |
| 0.01 | WIPE | ug/wipe | 746AES080W | U | |
| 0.1 | WIPE | ug/wipe | 746AES081W | | |
| 0.01 | WIPE | ug/wipe | 746AES082W | U | |
| **0.6** | **WIPE** | **ug/wipe** | **746AES083W** | | **Surface of mold** |
| 0.05 | WIPE | ug/wipe | 746AES084W | J | |
| **0.223** | **WIPE** | **ug/wipe** | **746AES085W** | | **Surface of mold** |
| 0.073 | WIPE | ug/wipe | 746AES086W | J | |
| 0.098 | WIPE | ug/wipe | 746AES087W | | |
| 0.048 | WIPE | ug/wipe | 746AES088W | J | |
| 0.048 | WIPE | ug/wipe | 746AES089W | J | |
| 0.048 | WIPE | ug/wipe | 746AES090W | J | |
| 0.048 | WIPE | ug/wipe | 746AES091W | J | |
| 0.048 | WIPE | ug/wipe | 746AES092W | J | |
| 0.048 | WIPE | ug/wipe | 746AES093W | J | |
| 0.023 | WIPE | ug/wipe | 746AES094W | J | |
| 0.018 | WIPE | ug/wipe | 746AES095W | J | |
| 0.018 | WIPE | ug/wipe | 746AES096W | J | |
| 0.018 | WIPE | ug/wipe | 746AES097W | J | |
| 0.043 | WIPE | ug/wipe | 746AES098W | J | |
| 0.068 | WIPE | ug/wipe | 746AES099W | J | |
| 0.018 | WIPE | ug/wipe | 746AES100W | J | |
| 0.043 | WIPE | ug/wipe | 746AES100WD | J | |
| 0.018 | WIPE | ug/wipe | 746AES101W | J | |
| 0.018 | WIPE | ug/wipe | 746AES102W | J | |
| 0.043 | WIPE | ug/wipe | 746AES103W | J | |
| 0.01 | WIPE | ug/wipe | 746AES104W | U | |
| 0.025 | WIPE | ug/wipe | 746AES105W | J | |
| 0.05 | WIPE | ug/wipe | 746AES106W | J | |
| 0.05 | WIPE | ug/wipe | 746AES107W | J | |
| 0.05 | WIPE | ug/wipe | 746AES108W | J | |
| 0.05 | WIPE | ug/wipe | 746AES109W | J | |
| 0.075 | WIPE | ug/wipe | 746AES110W | | |
| 0.05 | WIPE | ug/wipe | 746AES111W | J | |
| 0.01 | WIPE | ug/wipe | 746AES112W | U | |
| 0.1 | WIPE | ug/wipe | 746AES113W | | |
| 0.045 | WIPE | ug/wipe | 746AES114W | J | |
| 0.02 | WIPE | ug/wipe | 746AES115W | J | |

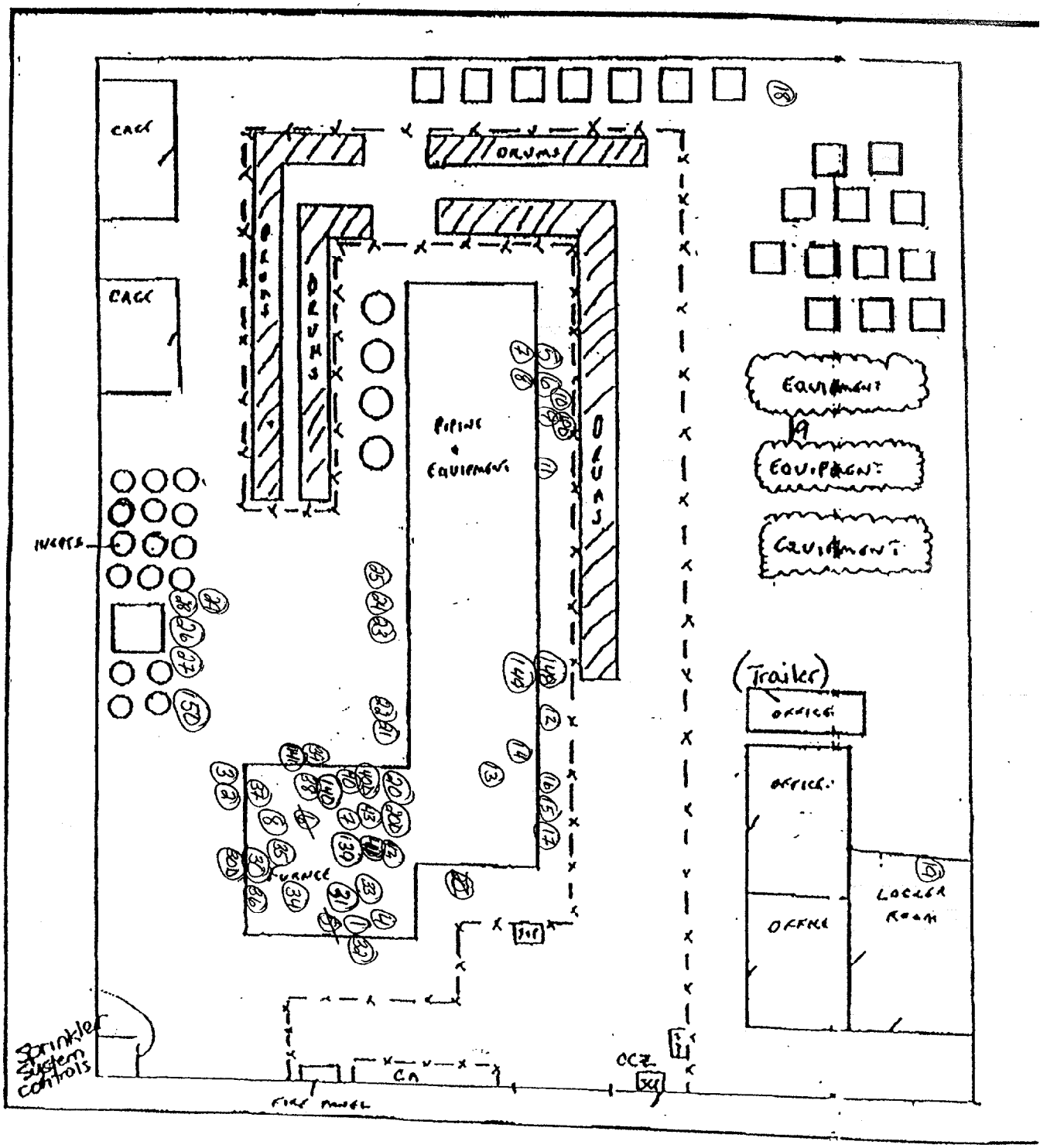
# C-746-A East Smelter
## All Samples

| RESULTS | MATRIX | UNITS | PROJ_SAMPLE_ID | RSLTQUAL | LOCATION |
|---|---|---|---|---|---|
| 0.02 | WIPE | ug/wipe | 746AES116W | J | |
| 0.045 | WIPE | ug/wipe | 746AES117W | J | |
| 0.07 | WIPE | ug/wipe | 746AES118W | J | |
| 0.01 | WIPE | ug/wipe | 746AES119W | U | |
| 0.145 | WIPE | ug/wipe | 746AES120W | | |
| **0.22** | **WIPE** | **ug/wipe** | **746AES121W** | | **Miscellaneouse equipment in NW corner** |
| 0.095 | WIPE | ug/wipe | 746AES122W | | |
| 0.01 | WIPE | ug/wipe | 746AES123W | U | |
| 0.058 | WIPE | ug/wipe | 746AES124W | J | |
| 0.055 | WIPE | ug/wipe | 746AES125W | J | |
| | | | | | |
| | **Minimum** | **Maximum** | | | |
| **Range** | **0.01** | **1.14** | | | |

# Paducah Gaseous Diffusion Plant

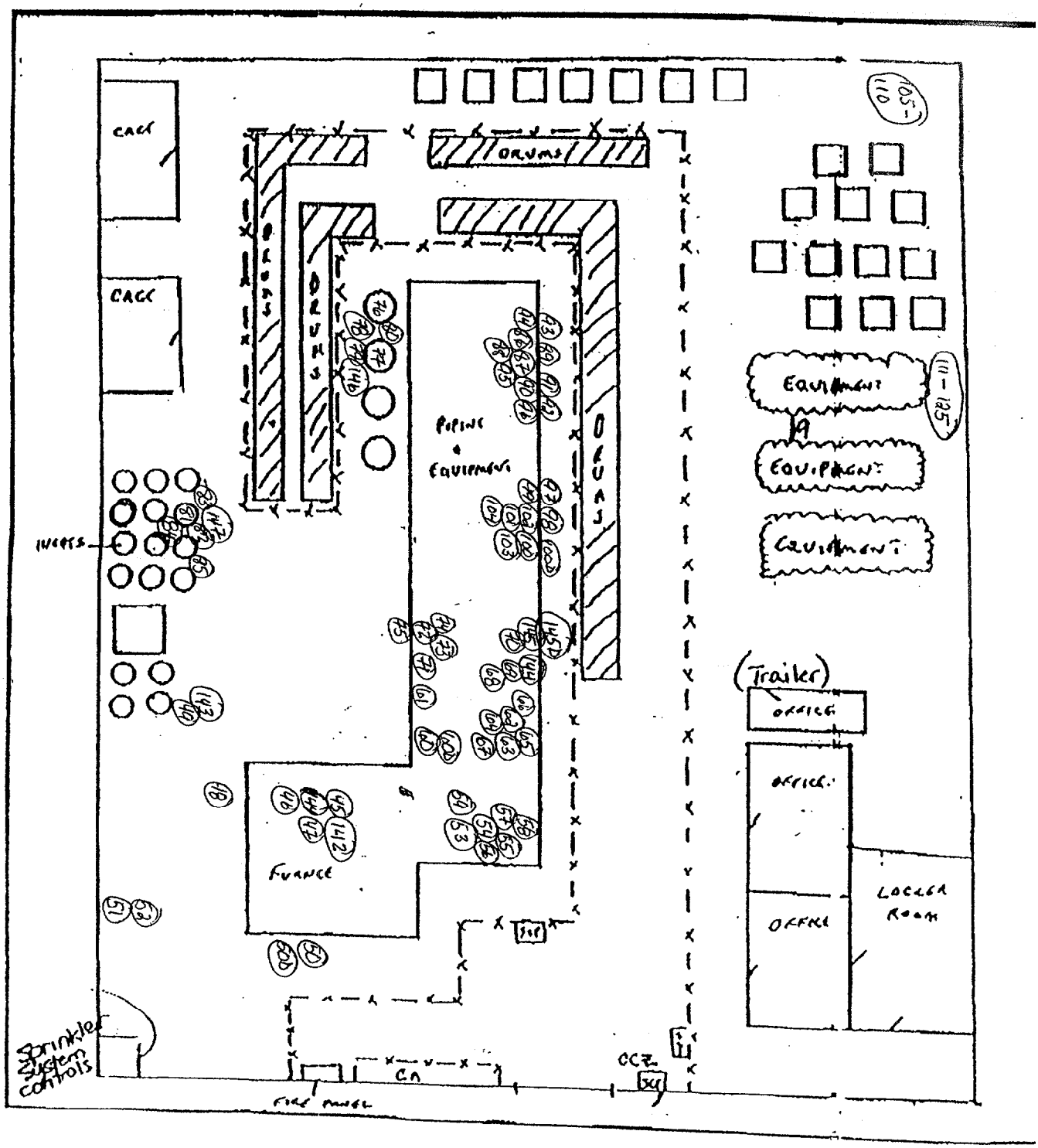
## C-746A East Smelter

Elevated



# Paducah Gaseous Diffusion Plant

## C-746A East Smelter



# APPENDIX L-2

## C-746 -A Building East Smelter Elevated Surfaces

# C-746-A East Smelter
## Wipe and Bulk Samples from Elevated Surfaces

| RESULTS | MATRIX | UNITS | PROJ_SAMPLE_ID | RSLTQUAL | LOCATION |
|---|---|---|---|---|---|
| **1.17** | **SOLID** | **mg/kg** | **746AES148B** | | **Miscellaneous elevated surface** |
| 0.5 | SOLID | mg/kg | 746AES149B | U | |
| **1.76** | **SOLID** | **mg/kg** | **746AES150B** | | **Miscellaneous elevated surface** |
| | | | | | |
| | **Minimum** | **Maximum** | | | |
| **Range** | **0.5** | **1.76** | | | |
| | | | | | |
| 0.1 | WIPE | ug/wipe | 746AES001W | | |
| 0.15 | WIPE | ug/wipe | 746AES002W | | |
| 0.125 | WIPE | ug/wipe | 746AES003W | | |
| 0.125 | WIPE | ug/wipe | 746AES004W | | |
| 0.025 | WIPE | ug/wipe | 746AES005W | J | |
| 0.075 | WIPE | ug/wipe | 746AES006W | | |
| 0.15 | WIPE | ug/wipe | 746AES007W | | |
| 0.05 | WIPE | ug/wipe | 746AES008W | J | |
| 0.025 | WIPE | ug/wipe | 746AES009W | J | |
| 0.05 | WIPE | ug/wipe | 746AES010W | J | |
| 0.04 | WIPE | ug/wipe | 746AES010WD | J | |
| 0.015 | WIPE | ug/wipe | 746AES011W | J | |
| **0.29** | **WIPE** | **ug/wipe** | **746AES012W** | | **Miscellaneous elevated surface** |
| 0.04 | WIPE | ug/wipe | 746AES013W | J | |
| 0.04 | WIPE | ug/wipe | 746AES014W | J | |
| **1.14** | **WIPE** | **ug/wipe** | **746AES015W** | | **Elevated surface - dust collector** |
| **0.84** | **WIPE** | **ug/wipe** | **746AES016W** | | **Elevated surface - duct** |
| 0.015 | WIPE | ug/wipe | 746AES017W | J | |
| 0.015 | WIPE | ug/wipe | 746AES018W | J | |
| 0.165 | WIPE | ug/wipe | 746AES019W | | |
| 0.145 | WIPE | ug/wipe | 746AES020W | | |
| 0.095 | WIPE | ug/wipe | 746AES020WD | | |
| **0.495** | **WIPE** | **ug/wipe** | **746AES021W** | | **Miscellaneous elevated surface** |
| **0.395** | **WIPE** | **ug/wipe** | **746AES022W** | | **Miscellaneous elevated surface** |
| 0.07 | WIPE | ug/wipe | 746AES023W | J | |
| **0.27** | **WIPE** | **ug/wipe** | **746AES024W** | | **Miscellaneous elevated surface** |
| **0.395** | **WIPE** | **ug/wipe** | **746AES025W** | | **Miscellaneous elevated surface** |
| 0.145 | WIPE | ug/wipe | 746AES026W | | |
| **0.345** | **WIPE** | **ug/wipe** | **746AES027W** | | **Miscellaneous elevated surface** |
| 0.045 | WIPE | ug/wipe | 746AES028W | J | |
| **0.42** | **WIPE** | **ug/wipe** | **746AES029W** | | **Miscellaneous elevated surface** |
| | | | | | |

# C-746-A East Smelter
## Wipe and Bulk Samples from Elevated Surfaces

| RESULTS | MATRIX | UNITS | PROJ_SAMPLE_ID | RSLTQUAL | LOCATION |
|---|---|---|---|---|---|
| | Minimum | Maximum | | | |
| Range | 0.015 | 1.14 | | | |

## Surface Wipe Sample Statistics

**Data Description:** C-746-A East Smelter Elevated Surfaces

| OEL |
|---|
| 0.2 |

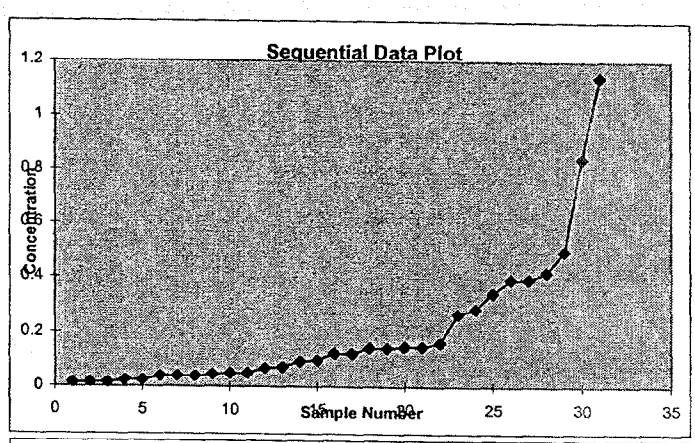
| Sample Data (max n = 50) No less-than (<) or greater-than (>) |
|---|
| 0.015 |
| 0.015 |
| 0.015 |
| 0.025 |
| 0.025 |
| 0.04 |
| 0.04 |
| 0.04 |
| 0.045 |
| 0.05 |
| 0.05 |
| 0.07 |
| 0.075 |
| 0.095 |
| 0.1 |
| 0.125 |
| 0.125 |
| 0.145 |
| 0.145 |
| 0.15 |
| 0.15 |
| 0.165 |
| 0.27 |
| 0.29 |
| 0.345 |
| 0.395 |
| 0.395 |
| 0.42 |
| 0.495 |
| 0.84 |
| 1.14 |

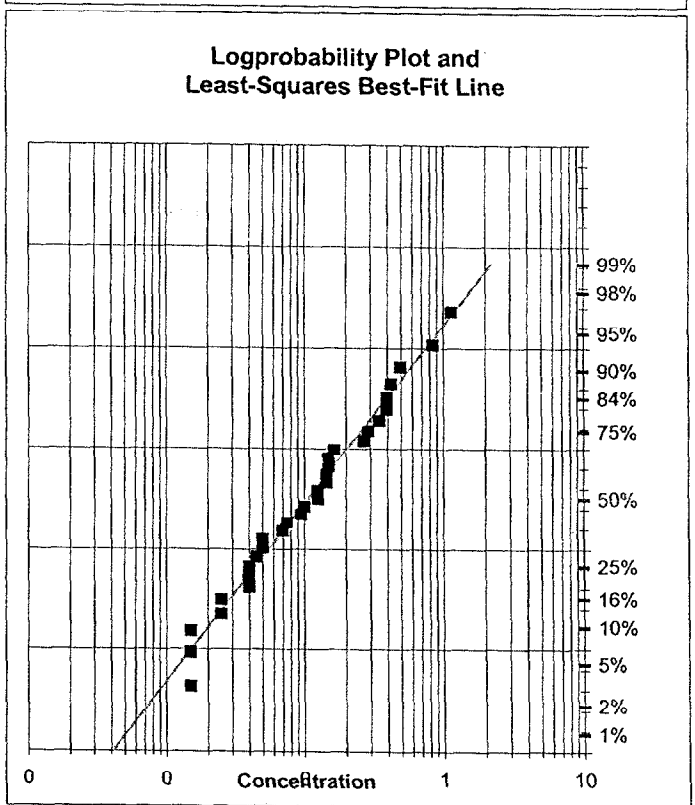
| DESCRIPTIVE STATISTICS | |
|---|---|
| Number of samples (n) | 31 |
| Maximum (max) | 1.14 |
| Minimum (min) | 0.015 |
| Range | 1.125 |
| Percent above OEL (%>OEL) | 29.032 |
| Mean | 0.203 |
| Median | 0.125 |
| Standard deviation (s) | 0.253 |
| Mean of logtransformed data (LN) | -2.237 |
| Std. deviation of logtransformed data (LN) | 1.187 |
| Geometric mean (GM) | 0.107 |
| Geometric standard deviation (GSD) | 3.278 |

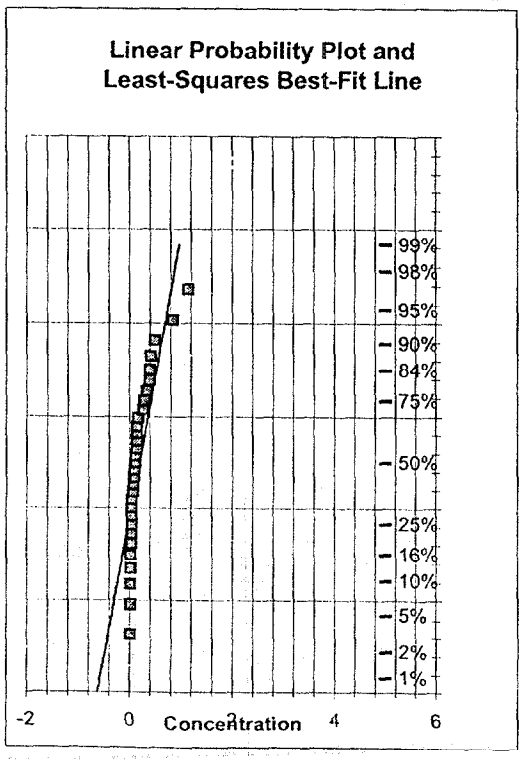
| TEST FOR DISTRIBUTION FIT | |
|---|---|
| W-test of logtransformed data (LN) | 0.966 |
| Lognormal (a = 0.05)? | Yes |
| W-test of data | 0.715 |
| Normal (a = 0.05)? | No |

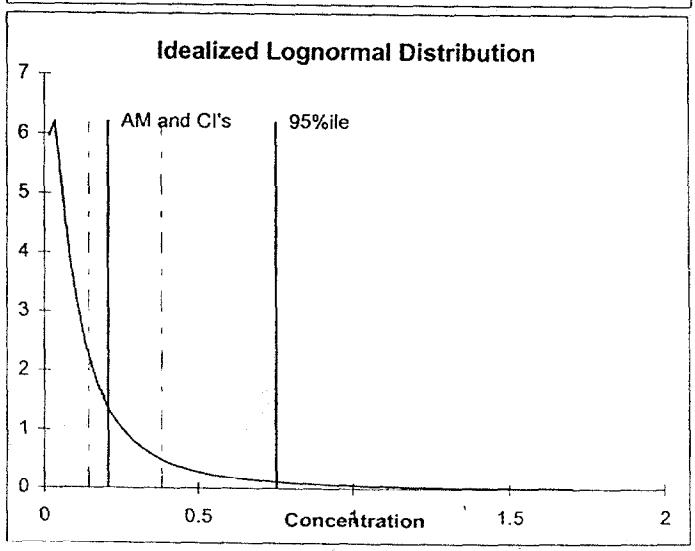
| LOGNORMAL PARAMETRIC STATISTICS | |
|---|---|
| **Estimated Arithmetic Mean - MVUE** | 0.208 |
| $LCL_{1,95\%}$ - Land's "Exact" | 0.144 |
| $UCL_{1,95\%}$ - Land's "Exact" | 0.382 |
| **95th Percentile** | 0.753 |
| $UTL_{95\%,95\%}$ | 1.472 |
| **Percent above OEL (%>OEL)** | 29.869 |
| $LCL_{1,95\%}$ %>OEL | 20.040 |
| $UCL_{1,95\%}$ %>OEL | 41.778 |

| NORMAL PARAMETRIC STATISTICS | |
|---|---|
| **Mean** | 0.203 |
| $LCL_{1,95\%}$ - t statistics | 0.126 |
| $UCL_{1,95\%}$ - t statistics | 0.280 |
| **95th Percentile - Z** | 0.620 |
| $UTL_{95\%,95\%}$ | 0.76 |
| **Percent above OEL (%>OEL)** | 50.483 |



# APPENDIX L-3

## C-746 -A Building East Smelter Mezzanine

# C-746-A East Smelter
## Wipe and Bulk Samples from Mezzanine

| RESULTS | MATRIX | UNITS | PROJ_SAMPLE_ID | RSLTQUAL |
|---|---|---|---|---|
| 0.5 | SOLID | mg/kg | 746AES139B | U |
| **0.744** | **SOLID** | **mg/kg** | **746AES140B** | |
| 0.5 | SOLID | mg/kg | 746AES141B | U |
| 0.5 | SOLID | mg/kg | 746AES142B | U |
| | | | | |
| | **Minimum** | **Maximum** | | |
| **Range** | **0.5** | **0.744** | | |
| | | | | |
| 0.145 | WIPE | ug/wipe | 746AES030W | |
| 0.143 | WIPE | ug/wipe | 746AES030WD | |
| 0.118 | WIPE | ug/wipe | 746AES031W | |
| 0.068 | WIPE | ug/wipe | 746AES032W | J |
| 0.068 | WIPE | ug/wipe | 746AES033W | J |
| 0.068 | WIPE | ug/wipe | 746AES034W | J |
| 0.018 | WIPE | ug/wipe | 746AES035W | J |
| 0.043 | WIPE | ug/wipe | 746AES036W | J |
| 0.018 | WIPE | ug/wipe | 746AES037W | J |
| 0.01 | WIPE | ug/wipe | 746AES038W | U |
| 0.01 | WIPE | ug/wipe | 746AES039W | U |
| 0.02 | WIPE | ug/wipe | 746AES040W | J |
| 0.02 | WIPE | ug/wipe | 746AES040WD | J |
| 0.01 | WIPE | ug/wipe | 746AES041WR | U |
| 0.01 | WIPE | ug/wipe | 746AES042W | U |
| 0.01 | WIPE | ug/wipe | 746AES043W | U |
| 0.045 | WIPE | ug/wipe | 746AES044W | J |
| 0.045 | WIPE | ug/wipe | 746AES045W | J |
| 0.02 | WIPE | ug/wipe | 746AES046W | J |
| 0.02 | WIPE | ug/wipe | 746AES047W | J |
| | | | | |
| | **Minimum** | **Maximum** | | |
| **Range** | **0.01** | **0.145** | | |

C-746-A East Smelter Mezzanine
Probability Plot

SUMMARY OUTPUT

| *Regression Statistics* | |
|---|---|
| Multiple R | 0.96536265 |
| R Square | 0.93192504 |
| Adjusted R Square | 0.9266885 |
| Standard Error | 0.21016356 |
| Observations | 15 |

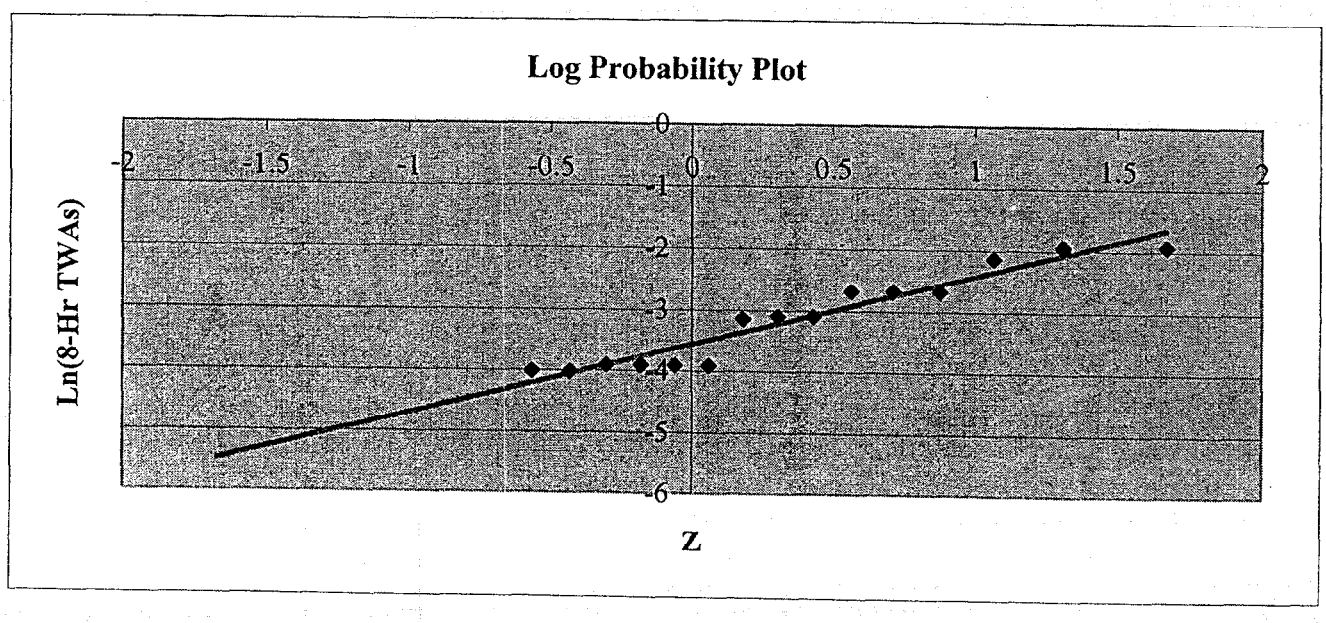
ANOVA

| | *df* | *SS* | *MS* | *F* | *Significance F* |
|---|---|---|---|---|---|
| Regression | 1 | 7.86052862 | 7.86052862 | 177.9659588 | 5.81111E-09 |
| Residual | 13 | 0.57419336 | 0.04416872 | | |
| Total | 14 | 8.43472198 | | | |

| | *Coefficients* | *Standard Error* | *t Stat* | *P-value* | *Lower 95%* | *Upper 95%* | *Lower 95.0%* | *Upper 95.0%* |
|---|---|---|---|---|---|---|---|---|
| Intercept | -3.56824838 | 0.0630246 | -56.6167532 | 6.00217E-17 | -3.704404727 | -3.43209203 | -3.70440473 | -3.43209203 |
| X Variable 1 | 1.13856936 | 0.08534754 | 13.3403883 | 5.81111E-09 | 0.954187236 | 1.32295148 | 0.95418724 | 1.32295148 |

| From Regression Output | | |
|---|---|---|
| Geometric Mean | 0.028 µg/100cm² | By EXP of Regression Intercept |
| Geometric Standard Deviation | 3.122 | By EXP of Regression Constant |
| Arithmetic Mean | 0.054 µg/100cm² | By EXP(ln GM + 1/2 (ln GSD)^2) |
| Estimated 95th Percentile | 0.184 µg/100cm² | By EXP(lnGM + 1.645*(ln GSD)) |
| Z value of OEL | 1.720 | By Z = [ln(OEL)-ln(GM)]/ln(GSD) |
| Percent less than OEL | 95.7% | By Excel NORMSDIST(Z) |
| 95/95 Geometric Upper Tolerance Limit | 0.423 µg/100cm² | By EXP(ln GM + K*(ln GSD)) |

| | | |
|---|---|---|
| a = | 0.9288 | = 1-Zg^2/(2*(n-1)) |
| b = | 2.5703 | = Zp^2-(Zg^2/n) |
| K = | 2.3783 | = (Zp+(Zp^2-(a*b))^0.5)/a |



# APPENDIX L-4

## C-746 -A Building East Smelter Equipment

# C-746-A East Smelter

## Wipe and Bulk Samples from Calciner Associated Equipment

| RESULTS | MATRIX | UNITS | PROJ_SAMPLE_ID | RSLTQUAL | LOCATION |
|---|---|---|---|---|---|
| 0.5 | SOLID | mg/kg | 746AES143B | U | |
| 0.5 | SOLID | mg/kg | 746AES144B | U | |
| 0.5 | SOLID | mg/kg | 746AES145B | U | |
| 0.5 | SOLID | mg/kg | 746AES145BD | U | |
| 0.5 | SOLID | mg/kg | 746AES146B | U | |
| **0.685** | **SOLID** | **mg/kg** | **746AES147B** | | |
| | | | | | |
| | **Minimum** | **Maximum** | | | |
| **Range** | **0.5** | **0.685** | | | |
| | | | | | |
| 0.095 | WIPE | ug/wipe | 746AES048W | | |
| 0.07 | WIPE | ug/wipe | 746AES049W | J | |
| 0.095 | WIPE | ug/wipe | 746AES050W | | |
| 0.07 | WIPE | ug/wipe | 746AES050WD | J | |
| 0.145 | WIPE | ug/wipe | 746AES051W | | |
| 0.045 | WIPE | ug/wipe | 746AES052W | J | |
| 0.07 | WIPE | ug/wipe | 746AES053W | J | |
| 0.07 | WIPE | ug/wipe | 746AES054W | J | |
| 0.045 | WIPE | ug/wipe | 746AES055W | J | |
| 0.01 | WIPE | ug/wipe | 746AES056W | U | |
| 0.05 | WIPE | ug/wipe | 746AES057W | J | |
| 0.025 | WIPE | ug/wipe | 746AES058W | J | |
| 0.025 | WIPE | ug/wipe | 746AES059W | J | |
| 0.05 | WIPE | ug/wipe | 746AES060W | J | |
| 0.075 | WIPE | ug/wipe | 746AES060WD | | |
| 0.05 | WIPE | ug/wipe | 746AES061W | J | |
| 0.15 | WIPE | ug/wipe | 746AES062W | | |
| 0.025 | WIPE | ug/wipe | 746AES063W | J | |
| 0.01 | WIPE | ug/wipe | 746AES064WR | U | |
| 0.145 | WIPE | ug/wipe | 746AES065W | N | |
| 0.07 | WIPE | ug/wipe | 746AES066W | JN | |
| 0.02 | WIPE | ug/wipe | 746AES067W | JN | |
| 0.02 | WIPE | ug/wipe | 746AES068W | JN | |
| 0.02 | WIPE | ug/wipe | 746AES069W | JN | |
| 0.045 | WIPE | ug/wipe | 746AES070W | JN | |
| 0.1 | WIPE | ug/wipe | 746AES071WR | | |
| 0.045 | WIPE | ug/wipe | 746AES072W | JN | |
| 0.045 | WIPE | ug/wipe | 746AES073W | JN | |
| 0.07 | WIPE | ug/wipe | 746AES074W | JN | |
| 0.025 | WIPE | ug/wipe | 746AES075W | J | |
| 0.05 | WIPE | ug/wipe | 746AES076W | J | |
| 0.075 | WIPE | ug/wipe | 746AES077W | | |
| 0.1 | WIPE | ug/wipe | 746AES078W | | |
| 0.05 | WIPE | ug/wipe | 746AES079W | J | |
| 0.01 | WIPE | ug/wipe | 746AES080W | U | |
| 0.1 | WIPE | ug/wipe | 746AES081W | | |
| 0.01 | WIPE | ug/wipe | 746AES082W | U | |
| **0.6** | **WIPE** | **ug/wipe** | **746AES083W** | | **Surface of mold** |
| 0.05 | WIPE | ug/wipe | 746AES084W | J | |

# C-746-A East Smelter
## Wipe and Bulk Samples from Calciner Associated Equipment

| RESULTS | MATRIX | UNITS | PROJ_SAMPLE_ID | RSLTQUAL | LOCATION |
|---|---|---|---|---|---|
| **0.223** | **WIPE** | **ug/wipe** | **746AES085W** | | **Surface of mold** |
| 0.073 | WIPE | ug/wipe | 746AES086W | J | |
| 0.098 | WIPE | ug/wipe | 746AES087W | | |
| 0.048 | WIPE | ug/wipe | 746AES088W | J | |
| 0.048 | WIPE | ug/wipe | 746AES089W | J | |
| 0.048 | WIPE | ug/wipe | 746AES090W | J | |
| 0.048 | WIPE | ug/wipe | 746AES091W | J | |
| 0.048 | WIPE | ug/wipe | 746AES092W | J | |
| 0.048 | WIPE | ug/wipe | 746AES093W | J | |
| 0.023 | WIPE | ug/wipe | 746AES094W | J | |
| 0.018 | WIPE | ug/wipe | 746AES095W | J | |
| 0.018 | WIPE | ug/wipe | 746AES096W | J | |
| 0.018 | WIPE | ug/wipe | 746AES097W | J | |
| 0.043 | WIPE | ug/wipe | 746AES098W | J | |
| 0.068 | WIPE | ug/wipe | 746AES099W | J | |
| 0.018 | WIPE | ug/wipe | 746AES100W | J | |
| 0.043 | WIPE | ug/wipe | 746AES100WD | J | |
| 0.018 | WIPE | ug/wipe | 746AES101W | J | |
| 0.018 | WIPE | ug/wipe | 746AES102W | J | |
| 0.043 | WIPE | ug/wipe | 746AES103W | J | |
| 0.01 | WIPE | ug/wipe | 746AES104W | U | |
| | | | | | |
| | **Minimum** | **Maximum** | | | |
| **Range** | **0.01** | **0.6** | | | |

# C-746-A East Smelter
## Wipe Samples from Misc. Equipment in NW Building Corner

| RESULTS | MATRIX | UNITS | PROJ_SAMPLE_ID | RSLTQUAL | LOCATION |
|---|---|---|---|---|---|
| 0.025 | WIPE | ug/wipe | 746AES105W | J | |
| 0.05 | WIPE | ug/wipe | 746AES106W | J | |
| 0.05 | WIPE | ug/wipe | 746AES107W | J | |
| 0.05 | WIPE | ug/wipe | 746AES108W | J | |
| 0.05 | WIPE | ug/wipe | 746AES109W | J | |
| 0.075 | WIPE | ug/wipe | 746AES110W | | |
| 0.05 | WIPE | ug/wipe | 746AES111W | J | |
| 0.01 | WIPE | ug/wipe | 746AES112W | U | |
| 0.1 | WIPE | ug/wipe | 746AES113W | | |
| 0.045 | WIPE | ug/wipe | 746AES114W | J | |
| 0.02 | WIPE | ug/wipe | 746AES115W | J | |
| 0.02 | WIPE | ug/wipe | 746AES116W | J | |
| 0.045 | WIPE | ug/wipe | 746AES117W | J | |
| 0.07 | WIPE | ug/wipe | 746AES118W | J | |
| 0.01 | WIPE | ug/wipe | 746AES119W | U | |
| 0.145 | WIPE | ug/wipe | 746AES120W | | |
| **0.22** | **WIPE** | **ug/wipe** | **746AES121W** | | **Miscellaneouse equipment in NW corner** |
| 0.095 | WIPE | ug/wipe | 746AES122W | | |
| 0.01 | WIPE | ug/wipe | 746AES123W | U | |
| 0.058 | WIPE | ug/wipe | 746AES124W | J | |
| 0.055 | WIPE | ug/wipe | 746AES125W | J | |
| | | | | | |
| | **Minimum** | **Maximum** | | | |
| **Range** | **0.01** | **0.22** | | | |

# APPENDIX M-1

## C-746 -A Building West Smelter

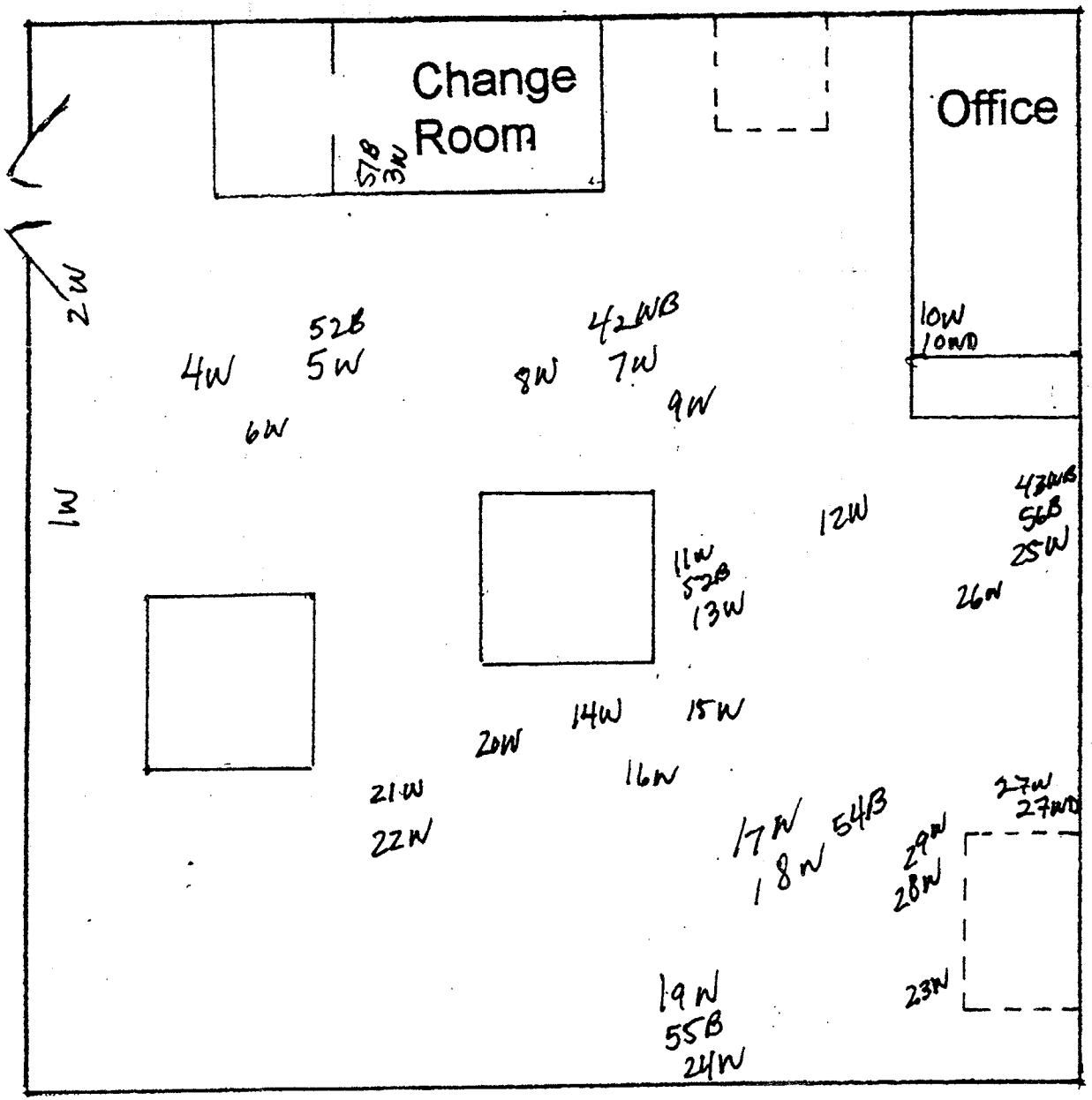
# C-746-A West Smelter
## All Samples

| RESULTS | MATRIX | UNITS | PROJ_SAMPLE_ID | RSLTQUAL | LOCATION |
|---|---|---|---|---|---|
| 0.01 | FILTER | ug/filter | 746AWS045P | U | |
| 0.01 | FILTER | ug/filter | 746AWS046P | U | |
| 0.01 | FILTER | ug/filter | 746AWS048A | U | |
| 0.01 | FILTER | ug/filter | 746AWS049A | U | |
| 0.01 | FILTER | ug/filter | 746AWS050A | U | |
| | | | | | |
| **0.97** | **SOLID** | **mg/kg** | **746AWS051B** | | **Top of change room** |
| 0.591 | SOLID | mg/kg | 746AWS052B | | |
| 0.563 | SOLID | mg/kg | 746AWS053B | | |
| 0.573 | SOLID | mg/kg | 746AWS054B | | |
| **2.26** | **SOLID** | **mg/kg** | **746AWS055B** | | **Light fixture** |
| 0.5 | SOLID | mg/kg | 746AWS056B | U | |
| **1.25** | **SOLID** | **mg/kg** | **746AWS057B** | | **Top of furnace** |
| **3.86** | **SOLID** | **mg/kg** | **746AWS058B** | | **Top of furnace** |
| 0.5 | SOLID | mg/kg | 746AWS059B | U | |
| 0.5 | SOLID | mg/kg | 746AWS060B | U | |
| **3.74** | **SOLID** | **mg/kg** | **746AWS061B** | | **Top of furnace** |
| 0.5 | SOLID | mg/kg | 746AWS062B | U | |
| | | | | | |
| | **Minimum** | **Maximum** | | | |
| **Range** | **0.5** | **3.86** | | | |
| | | | | | |
| 0.095 | WIPE | ug/wipe | 746AWS001W | | |
| 0.045 | WIPE | ug/wipe | 746AWS002W | J | |
| **0.245** | **WIPE** | **ug/wipe** | **746AWS003W** | | **Top of change room** |
| **2** | **WIPE** | **ug/wipe** | **746AWS004W** | | **Fire protection pipe** |
| **0.395** | **WIPE** | **ug/wipe** | **746AWS005W** | | **I-beam** |
| 0.025 | WIPE | ug/wipe | 746AWS006WR | J | |
| 0.02 | WIPE | ug/wipe | 746AWS007W | J | |
| **0.395** | **WIPE** | **ug/wipe** | **746AWS008W** | | **Fire protection pipe** |
| 0.045 | WIPE | ug/wipe | 746AWS009W | J | |
| 0.195 | WIPE | ug/wipe | 746AWS010W | | |
| 0.195 | WIPE | ug/wipe | 746AWS010WD | | |
| **0.545** | **WIPE** | **ug/wipe** | **746AWS011W** | | **I-beam** |
| **0.47** | **WIPE** | **ug/wipe** | **746AWS012W** | | **Fire protection pipe** |
| **1.17** | **WIPE** | **ug/wipe** | **746AWS013W** | | **Winch arm post** |
| 0.02 | WIPE | ug/wipe | 746AWS014W | J | |
| 0.023 | WIPE | ug/wipe | 746AWS015W | J | |
| **0.623** | **WIPE** | **ug/wipe** | **746AWS016W** | | **Light fixture** |
| 0.123 | WIPE | ug/wipe | 746AWS017W | | |
| **0.648** | **WIPE** | **ug/wipe** | **746AWS018W** | | **Fire protection pipe** |
| **0.873** | **WIPE** | **ug/wipe** | **746AWS019W** | | **Light fixture** |
| 0.048 | WIPE | ug/wipe | 746AWS020W | J | |
| 0.023 | WIPE | ug/wipe | 746AWS021W | J | |
| **0.248** | **WIPE** | **ug/wipe** | **746AWS022W** | | **Fire protection pipe** |
| 0.123 | WIPE | ug/wipe | 746AWS023W | | |
| **0.348** | **WIPE** | **ug/wipe** | **746AWS024W** | | **Light fixture** |
| 0.075 | WIPE | ug/wipe | 746AWS025W | | |
| 0.1 | WIPE | ug/wipe | 746AWS026W | | |

# C-746-A West Smelter
## All Samples

| RESULTS | MATRIX | UNITS | PROJ_SAMPLE_ID | RSLTQUAL | LOCATION |
|---|---|---|---|---|---|
| **0.25** | **WIPE** | **ug/wipe** | **746AWS027W** | **J** | **Light fixture** |
| 0.025 | WIPE | ug/wipe | 746AWS027WD | J | |
| 0.025 | WIPE | ug/wipe | 746AWS028W | J | |
| 0.025 | WIPE | ug/wipe | 746AWS029W | J | |
| **0.203** | **WIPE** | **ug/wipe** | **746AWS030W** | **JN** | **Top of furnace** |
| **0.298** | **WIPE** | **ug/wipe** | **746AWS031W** | | **Top of furnace** |
| 0.048 | WIPE | ug/wipe | 746AWS032W | J | |
| 0.015 | WIPE | ug/wipe | 746AWS033W | U | |
| 0.048 | WIPE | ug/wipe | 746AWS034W | J | |
| 0.073 | WIPE | ug/wipe | 746AWS035W | J | |
| **0.348** | **WIPE** | **ug/wipe** | **746AWS036W** | | **Top of furnace** |
| 0.023 | WIPE | ug/wipe | 746AWS037W | J | |
| **0.375** | **WIPE** | **ug/wipe** | **746AWS038WR** | | **Top of furnace** |
| **0.8** | **WIPE** | **ug/wipe** | **746AWS039WDR** | | **Furnace** |
| **0.8** | **WIPE** | **ug/wipe** | **746AWS039WR** | | **Furnace** |
| 0.05 | WIPE | ug/wipe | 746AWS040WR | J | |
| 0.09 | WIPE | ug/wipe | 746AWS041W | | |
| | | | | | |
| | **Minimum** | **Maximum** | | | |
| **Range** | **0.015** | **2** | | | |

# C-746 A
# West Smelter



# APPENDIX M-2

# C-746 -A Building West Smelter Elevated Surfaces

# C-746-A West Smelter
## Wipe and Bulk Samples from Elevated Surfaces

| RESULTS | MATRIX | UNITS | PROJ_SAMPLE_ID | RSLTQUAL | LOCATION |
|---|---|---|---|---|---|
| **0.97** | **SOLID** | **mg/kg** | **746AWS051B** | | **Top of change room** |
| 0.591 | SOLID | mg/kg | 746AWS052B | | |
| 0.563 | SOLID | mg/kg | 746AWS053B | | |
| 0.573 | SOLID | mg/kg | 746AWS054B | | |
| **2.26** | **SOLID** | **mg/kg** | **746AWS055B** | | **Light fixture** |
| | | | | | |
| | **Minimum** | **Maximum** | | | |
| **Range** | **0.563** | **2.26** | | | |
| | | | | | |
| 0.095 | WIPE | ug/wipe | 746AWS001W | | |
| 0.045 | WIPE | ug/wipe | 746AWS002W | J | |
| **0.245** | **WIPE** | **ug/wipe** | **746AWS003W** | | **Top of change room** |
| **2** | **WIPE** | **ug/wipe** | **746AWS004W** | | **Fire protection pipe** |
| **0.395** | **WIPE** | **ug/wipe** | **746AWS005W** | | **I-beam** |
| 0.025 | WIPE | ug/wipe | 746AWS006WR | J | |
| 0.02 | WIPE | ug/wipe | 746AWS007W | J | |
| **0.395** | **WIPE** | **ug/wipe** | **746AWS008W** | | **Fire protection pipe** |
| 0.045 | WIPE | ug/wipe | 746AWS009W | J | |
| 0.195 | WIPE | ug/wipe | 746AWS010W | | |
| 0.195 | WIPE | ug/wipe | 746AWS010WD | | |
| **0.545** | **WIPE** | **ug/wipe** | **746AWS011W** | | **I-beam** |
| **0.47** | **WIPE** | **ug/wipe** | **746AWS012W** | | **Fire protection pipe** |
| **1.17** | **WIPE** | **ug/wipe** | **746AWS013W** | | **Winch arm post** |
| 0.02 | WIPE | ug/wipe | 746AWS014W | J | |
| 0.023 | WIPE | ug/wipe | 746AWS015W | J | |
| **0.623** | **WIPE** | **ug/wipe** | **746AWS016W** | | **Light fixture** |
| 0.123 | WIPE | ug/wipe | 746AWS017W | | |
| **0.648** | **WIPE** | **ug/wipe** | **746AWS018W** | | **Fire protection pipe** |
| **0.873** | **WIPE** | **ug/wipe** | **746AWS019W** | | **Light fixture** |
| 0.048 | WIPE | ug/wipe | 746AWS020W | J | |
| 0.023 | WIPE | ug/wipe | 746AWS021W | J | |
| **0.248** | **WIPE** | **ug/wipe** | **746AWS022W** | | **Fire protection pipe** |
| 0.123 | WIPE | ug/wipe | 746AWS023W | | |
| **0.348** | **WIPE** | **ug/wipe** | **746AWS024W** | | **Light fixture** |
| 0.075 | WIPE | ug/wipe | 746AWS025W | | |
| 0.1 | WIPE | ug/wipe | 746AWS026W | | |
| **0.25** | **WIPE** | **ug/wipe** | **746AWS027W** | **J** | **Light fixture** |
| 0.025 | WIPE | ug/wipe | 746AWS027WD | J | |
| 0.025 | WIPE | ug/wipe | 746AWS028W | J | |
| 0.025 | WIPE | ug/wipe | 746AWS029W | J | |
| | | | | | |
| | **Minimum** | **Maximum** | | | |
| **Range** | **0.02** | **2** | | | |

# APPENDIX M-3

## C-746 -A Building West Smelter Furnaces

# C-746-A West Smelter
## Wipe and Bulk Samples from Furnace Exteriors

| RESULTS | MATRIX | UNITS | PROJ_SAMPLE_ID | RSLTQUAL | LOCATION |
|---|---|---|---|---|---|
| **1.25** | **SOLID** | **mg/kg** | **746AWS057B** | | **Top of furnace** |
| **3.86** | **SOLID** | **mg/kg** | **746AWS058B** | | **Top of furnace** |
| 0.5 | SOLID | mg/kg | 746AWS059B | U | |
| 0.5 | SOLID | mg/kg | 746AWS060B | U | |
| **3.74** | **SOLID** | **mg/kg** | **746AWS061B** | | **Top of furnace** |
| 0.5 | SOLID | mg/kg | 746AWS062B | U | |
| | | | | | |
| | **Minimum** | **Maximum** | | | |
| **Range** | **0.5** | **3.86** | | | |
| | | | | | |
| **0.203** | **WIPE** | **ug/wipe** | **746AWS030W** | **JN** | **Top of furnace** |
| **0.298** | **WIPE** | **ug/wipe** | **746AWS031W** | | **Top of furnace** |
| 0.048 | WIPE | ug/wipe | 746AWS032W | J | |
| 0.015 | WIPE | ug/wipe | 746AWS033W | U | |
| 0.048 | WIPE | ug/wipe | 746AWS034W | J | |
| 0.073 | WIPE | ug/wipe | 746AWS035W | J | |
| **0.348** | **WIPE** | **ug/wipe** | **746AWS036W** | | **Top of furnace** |
| 0.023 | WIPE | ug/wipe | 746AWS037W | J | |
| **0.375** | **WIPE** | **ug/wipe** | **746AWS038WR** | | **Top of furnace** |
| **0.8** | **WIPE** | **ug/wipe** | **746AWS039WDR** | | **Furnace** |
| **0.8** | **WIPE** | **ug/wipe** | **746AWS039WR** | | **Furnace** |
| 0.05 | WIPE | ug/wipe | 746AWS040WR | J | |
| 0.09 | WIPE | ug/wipe | 746AWS041W | | |
| | | | | | |
| | **Minimum** | **Maximum** | | | |
| **Range** | **0.015** | **0.8** | | | |

## Surface Wipe Sampling Statistics

**Data Description:** C-746-A West Smelter Furnaces

| OEL |
|---|
| 0.2 |

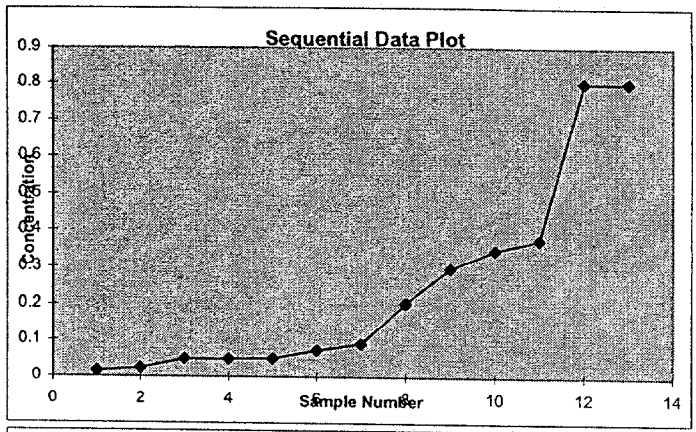
| Sample Data (max n = 50) No less-than (<) or greater-than (>) |
|---|
| 0.015 |
| 0.023 |
| 0.048 |
| 0.048 |
| 0.05 |
| 0.073 |
| 0.09 |
| 0.203 |
| 0.298 |
| 0.348 |
| 0.375 |
| 0.8 |
| 0.8 |

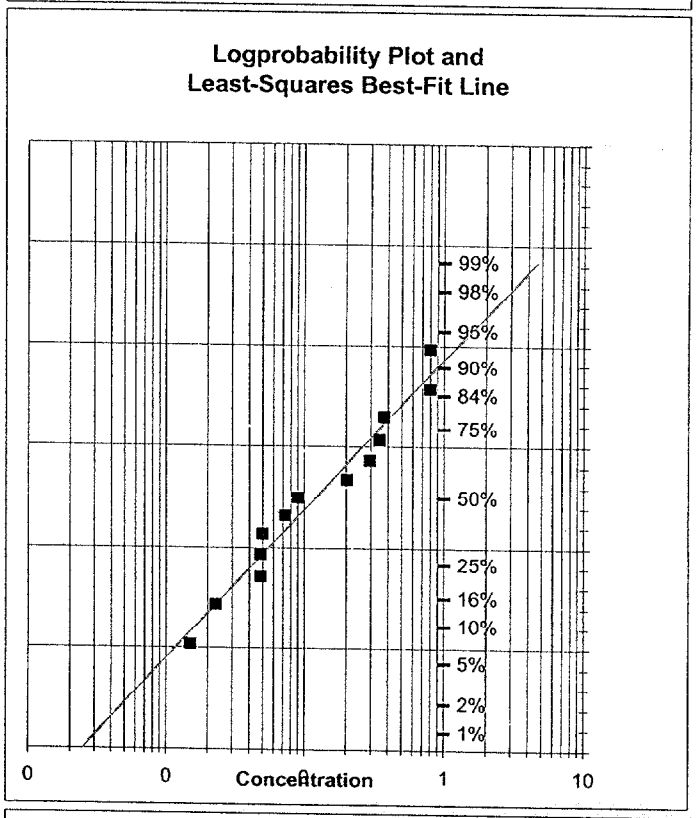
| DESCRIPTIVE STATISTICS | |
|---|---|
| Number of samples (n) | 13 |
| Maximum (max) | 0.8 |
| Minimum (min) | 0.015 |
| Range | 0.785 |
| Percent above OEL (%>OEL) | 46.154 |
| Mean | 0.244 |
| Median | 0.090 |
| Standard deviation (s) | 0.277 |
| Mean of logtransformed data (LN) | -2.104 |
| Std. deviation of logtransformed data (LN) | 1.309 |
| Geometric mean (GM) | 0.122 |
| Geometric standard deviation (GSD) | 3.702 |

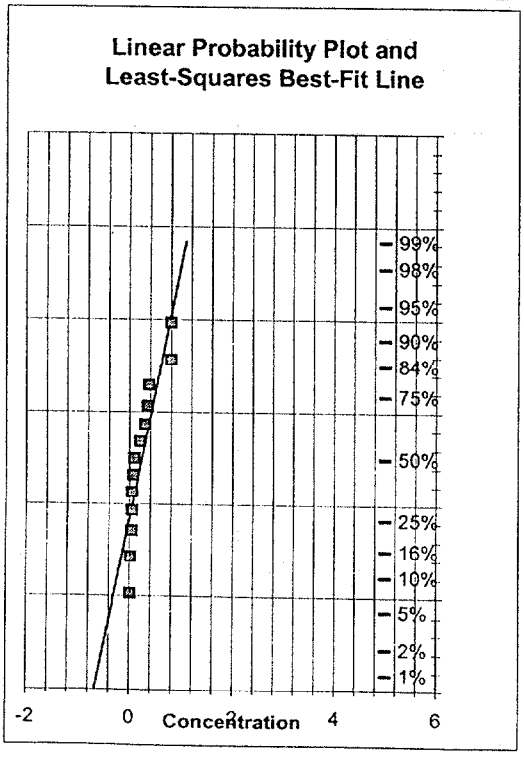
| TEST FOR DISTRIBUTION FIT | |
|---|---|
| W-test of logtransformed data (LN) | 0.940 |
| Lognormal (a = 0.05)? | Yes |
| W-test of data | 0.774 |
| Normal (a = 0.05)? | No |

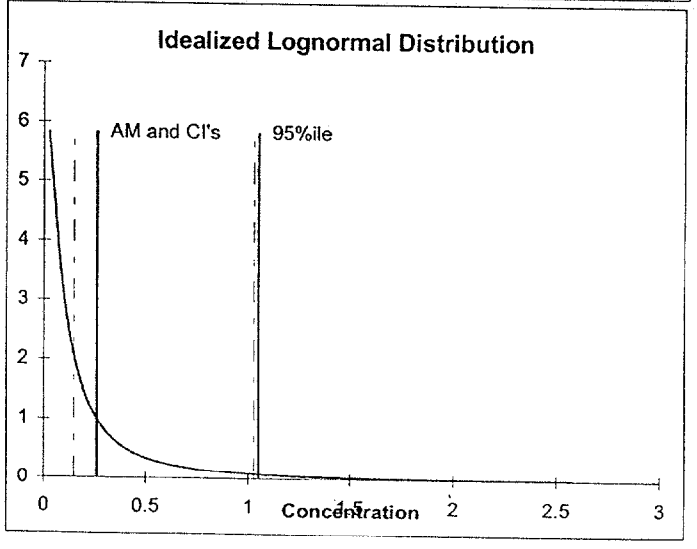
| LOGNORMAL PARAMETRIC STATISTICS | |
|---|---|
| **Estimated Arithmetic Mean - MVUE** | 0.258 |
| $LCL_{1,95\%}$ - Land's "Exact" | 0.145 |
| $UCL_{1,95\%}$ - Land's "Exact" | 1.027 |
| **95th Percentile** | 1.050 |
| $UTL_{95\%,95\%}$ | 4.017 |
| **Percent above OEL (%>OEL)** | 35.273 |
| $LCL_{1,95\%}$ %>OEL | 19.939 |
| $UCL_{1,95\%}$ %>OEL | 54.147 |

| NORMAL PARAMETRIC STATISTICS | |
|---|---|
| **Mean** | 0.244 |
| $LCL_{1,95\%}$ - t statistics | 0.107 |
| $UCL_{1,95\%}$ - t statistics | 0.381 |
| **95th Percentile - Z** | 0.699 |
| $UTL_{95\%,95\%}$ | 0.98 |
| **Percent above OEL (%>OEL)** | 56.304 |

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